Concrete

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The Man and the Job

A Christmas Fantasy, With Proofs

By H. G. Badder
London, England

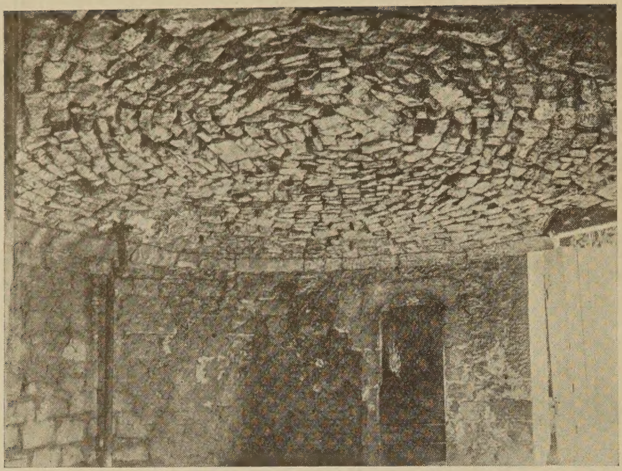
A man who thinks of his jobs of concreting as labors upon monuments that will proclaim his intelligence, his skill and his integrity to generations that are to follow after him, gives a meaning to the Slogan: "Concrete for Permanence" that can be given it in no other way. The character of the builder is proclaimed in his work—
The Editor

THE reader, having worked all the year at the absorbing task of making an income out of concrete work, may indulge himself at Christmas time, after counting up his profits—if any—in the usual festivities, but may also devote a little thought to his hobby of mixing stones with cement for a living, and about the men who did this work in the past, and those who will do it in the future.

No doubt he will consider he is living in an age of marvellous constructions in concrete that his ancestors could not dream of, and may wish he had the delightful job of showing one of them round to see him gasp with awe and astonishment.

But everything has a beginning, and as a little corrective to his swelling vanity, also to show him that there is nothing new under the sun, the following little history is appended, with illustrative proof that can be authenticated.

Barnard Castle, County of Durham, Above the River Teese, Has a 12th Century "Concrete Floor"



Interior, Baliol Tower, Barnard Castle, from Ground Floor, showing Underside of John-O-Marwood's Floor. The Water-pipe was added in Recent Years to Carry off Rain Water from Floor Above, the Roof to the Tower Having Decayed and Fallen in, Probably Because the Cover of Lead was Stolen. The End of the Pipe is Carried Through the Wall to Empty Outside the Tower

About the year 1136 Bernard Baliol, son of Guy Baliol, who came over from Normandy with William the Conqueror, was making additions to his castle, and was building a Keep to be named the Baliol Tower.

To protect himself from raiding neighbors, whose playful habit was to smoke or burn out the defenders if they won their way into the Keep, Bernard demanded his workmen to construct him a first floor that would not burn, but none was skilful enough to do so.

His tower was built up to the first floor level and stopped, waiting for the problem to be solved, and while Bernard harried and cursed his men for the delay, he could not solve the problem himself—he could only fight—and his foster brother, the prior at the neighboring monastery, searched his scanty stock of books in vain.

Then John-O-Marwood strolled on to the scene, returning after years of wandering so long that he was forgotten by the people of his youthful days, when he had worked as a prentice mason at the building of the priory. He made himself known, and was soon hurried before his chieftain, who spoke of his desire, while he eyed the mason closely.

"An thy tale be true, O Builder, then shall ye be bountily rewarded, but if thou fail, it shall go hard with thee to hold thy life when I am done with thee."

"Thy word are fair, Great Lord, yet I may quest a sworn boon that thou will let no man touch the floor with hand or foot for forty days and nights after it is laid by me for thee."

"By my good sword, trespass man or woman on thy work an it will end their fault. Do thou but get to work! Choose now thy laborers from my village. Take this, my ring, for to find and demand that thou needst to do this my wish! Hurry all, and thou build quickly! Lodge in this my castle! Now, to work! delay thou not, nor lag thy forty days, as I wish thee well."

The mason withdrew to view the tower and workmen, whose labor had brought the walls up to floor level where they were stopped. There he spent an hour while the men eyed him anxiously, then he gave his orders, and workmen with their gangers brought him timber, others stones for the walls, while the wallers and masons were soon busy building up the tower walls again.

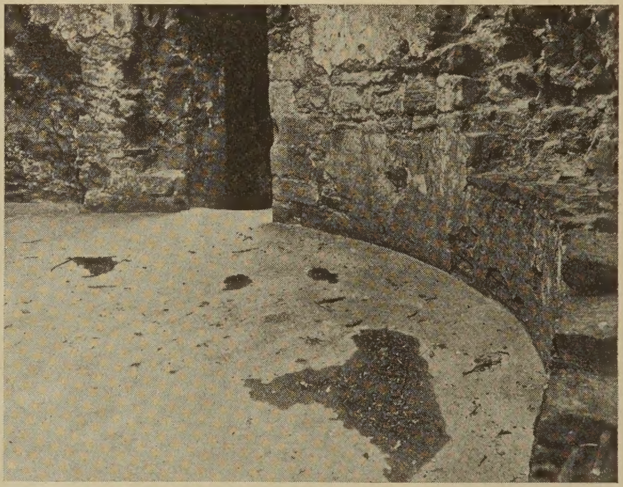
Some marvelled as to what he would be doing in raising the walls without the floor, but he kept his own council. Days passed, he had the workmen construct him a floor of timber supported by wood props, then he selected stones of certain shape, and had a bed of hot lime slacked with a bullock's blood mixed with water, turned his masons on to the temporary floor to lay the stones, well grouted with his mortar of blood-tempered lime mixed with sand and finely broken brick. Round and round from the circular walls of the tower the masons laid the stones until the centre was reached, and John-O-Marwood cut a stone to fit as a keystone, for his mark is upon it.

The stones, well grouted up, he covered with three inches of his special mortar and smoothed the surface; by this time the tower walls were built their full height and covered with an oak beamed top, while above it the parapet wall was being erected.

Bernard, who had eagerly watched these efforts, put a guard of men-at-arms on duty at the tower for forty days at John-O-Marwood's request and as he had sworn, and bided his time with great restraint.

Then came the day of test, full of assured confidence John-O-Marwood removed his temporary floor, cunningly he had given the stones a slight rise from the walls to the centre.

"Fill it with your men-at-arms, good my Lord," he asked of Bernard, looking on. "Nay, by our Lady," he growled in reply, "villagers will do," and crowded it with doubtful villagers. It stood the test, John watching it in confident ease, while Bernard, with bright kindling eye, spoke.



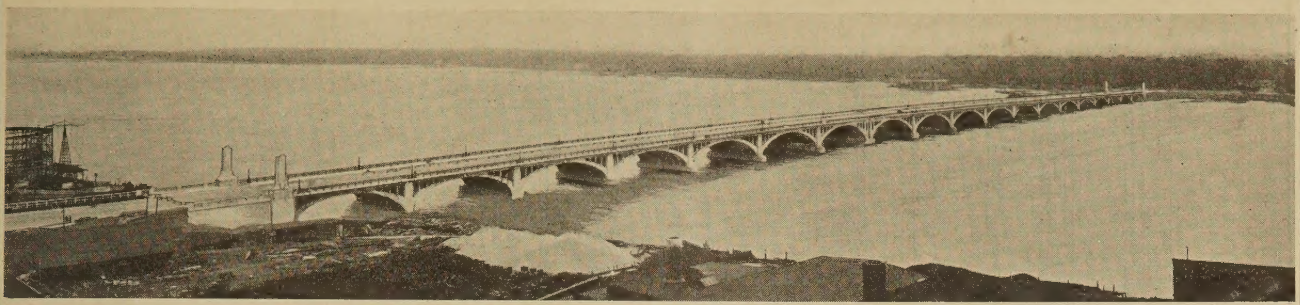
Twelfth-Century Concrete Floor Viewed from Above. The Damage to Walls was Caused by Cromwell's Cannon Shot

"Hark ye, John-O-Marwood, I who have prayed no man, pray thee be my builder, and none shall come betwixt me and thee in these works."

Baliol Tower, whose top is 200 feet high "standing stately upon the Teese," is broken and weather worn by centuries of storm, with the roof and parapet gone, but the floor is still in good condition. Cromwell's guns did it no damage, nor the feuds and fights of earlier days. The floor was a wonder to see in its freshness; and that the villagers' saying:

"That Barnard's Castle was built of Marwood's stone" has been twisted by blundering archeologists to mean something quite different, is not the fault of the writer.

This tower and castle is described in Sir Walter Scott's poem of "Rokeby," and Charles Dickens gathered notes for his stories of "Nicholas Nickleby" and "Master Humprie's Clock" at Barnard Castle Town in the county of Durham.



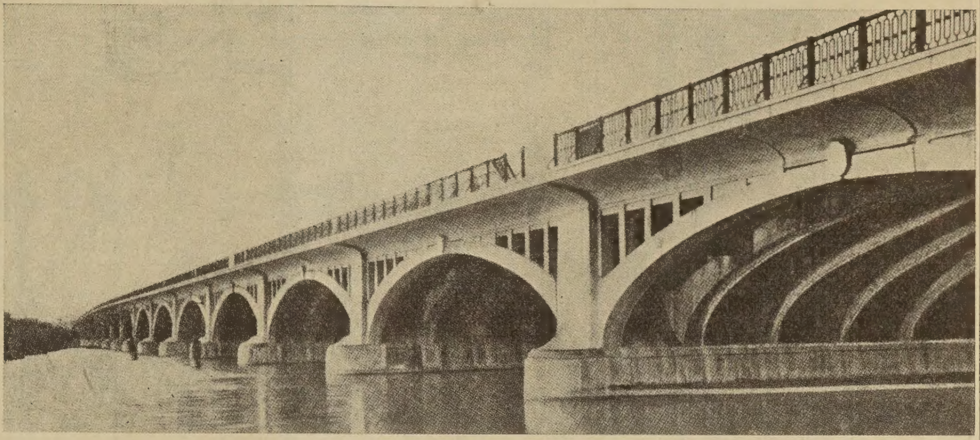


Fig. 1—The New Belle Isle Bridge, Detroit, Mich.

Fig. 2—Close Up View of Bridge as Completed Except for Lamp Posts and Sections of Railings

Detroit Belle Isle Bridge a Reinforced Concrete Cantilever Structure

The new Belle Isle bridge at Detroit, Mich., just completed and opened to the public November 1, is a reinforced concrete double cantilever structure, unique in its design and construction. It is the second of its type to be built in the United States, the only other structure of similar design being the Hanover street bridge in Baltimore, Md. The cost of construction of the bridge and approaches was financed by a $3,000,000 bond issue voted by the people of Detroit to replace the original steel framed structure which connected the city with Belle Isle and which was destroyed by fire in 1915.

The lack of rock foundation at a reasonable depth at the bridge site was a factor in determining the type of structure designed. Test borings indicated that underlying rock was at least 90 ft. below water level. Although some features of construction were more expensive than for the ordinary type of reinforced concrete arch structure, this type of construction as adopted worked out to advantage under the governing conditions. Any additional cost in the steel reinforcement as designed was more than offset by economies in construction work, particularly by the omission of false work in the spans.

The new bridge is near the site of the old structure, at right angles to the flow of the stream. It spans that part of the Detroit river that flows on the north side of the island which is Detroit's most popular playground.

Although having all the artistic features of an arch structure, each of the spans consists of reinforced concrete cantilevers, which have the appearance of arch rings, extending from the adjacent piers and supporting girders which form the mid span sections. This type of construction and the erection methods adopted permitted the construction of the bridge without the false work necessary for the usual type of reinforced concrete arch.

The total length of the bridge is 2193.5 ft. from the center of pier 0 to the center of pier 19, there being 19 spans and a shore span. These spans vary in length from 74 ft. to 135 ft. with a maximum clearance of 31 ft. under the highest span. No draw span was provided in the design of the new bridge.

The roadway between curbs is 59 ft. wide including a double track car line along the east curb. The total width of sidewalk and railing from curb to outer edge of cantilever is 14 ft., the center line of the railing being 5 ft. 11½ in. outside the center line of the outer cantilever rib. The railings and lamp posts are ornamental iron. Two concrete pylons add to the impressiveness of each approach, one pylon at either side.

The reinforcement for the reinforced concrete cantilevers is made up of structural steel shapes so designed as to be self-supporting and also to carry the combined weight of the form work for the ribs corresponding to arch ribs and the wet concrete in these forms. Different methods for erecting the cantilever reinforcement were considered, including the use of travellers working out from each end of the span. The main tension reinforcement consists of eye-bars as shown in Fig. 3. They are pin connected at the ends and extend from the steel frame above the pier to the outer end of the

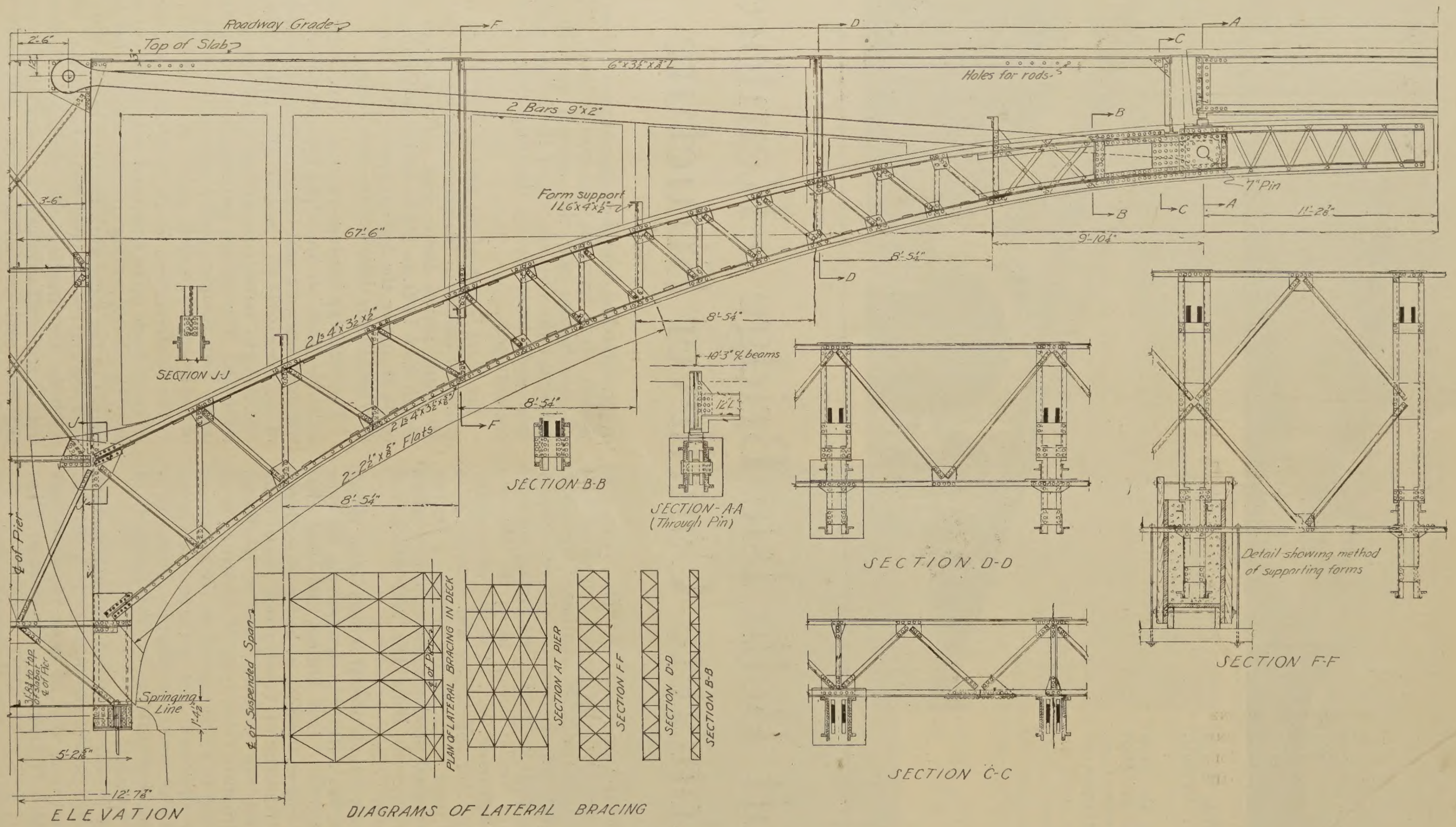


Fig. 3—Typical Details of Steel Reinforcement Showing Arrangement for Supporting Forms for Concrete

Details in Fig. 3 are typical for pier units 1 to 18 inclusive and as shown are for piers 5, 6, 7 and 8. The material shown is common to all units except that the eye bars, the 6-in. x 3½-in. x ⅜-in. strut angle and the center plate and angle girders are variable. Variations in dimensions of the various units conform to the change in grade and span length.

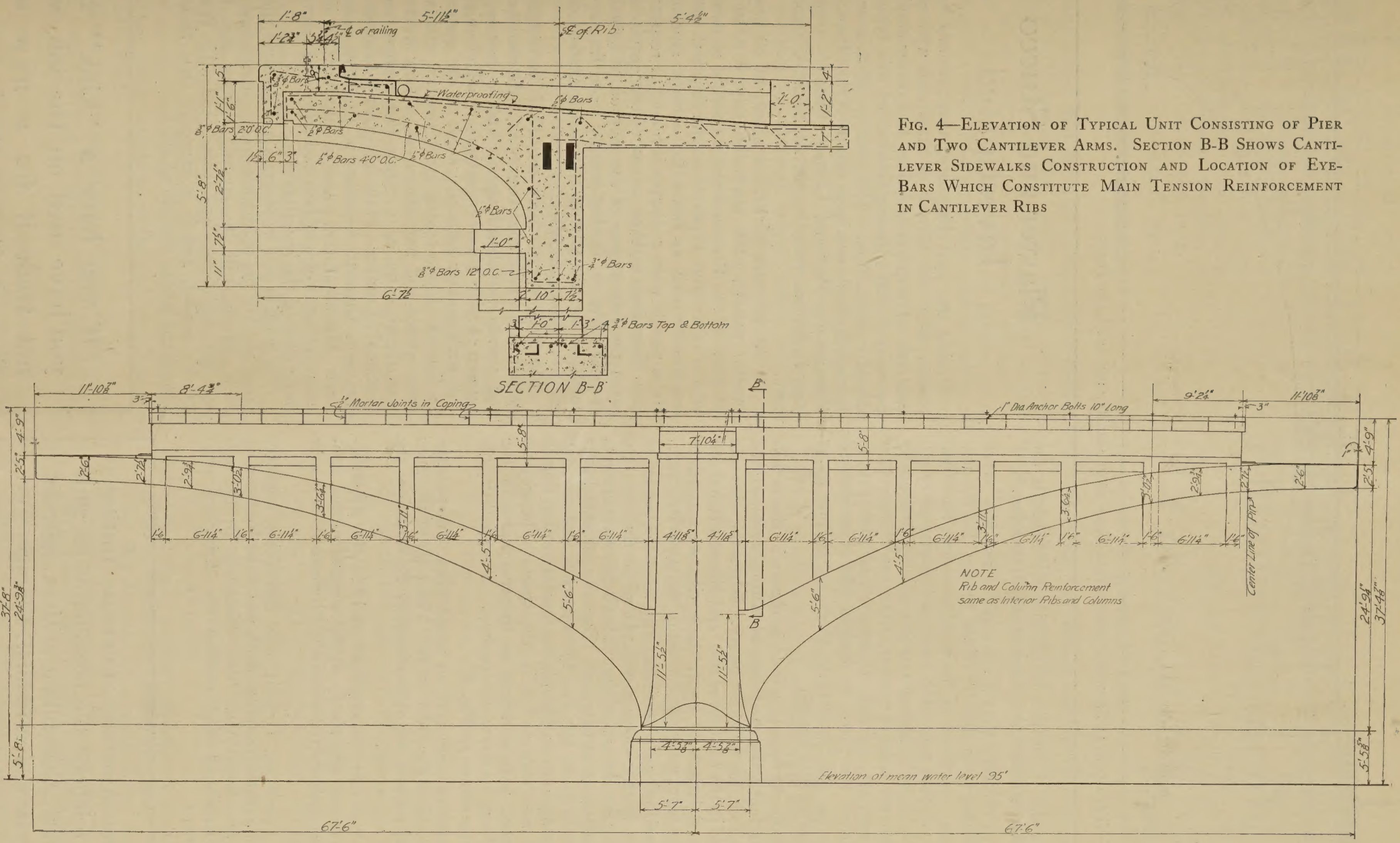


Fig. 4—Elevation of Typical Unit Consisting of Pier and Two Cantilever Arms. Section B-B Shows Cantilever Sidewalks Construction and Location of Eye-Bars Which Constitute Main Tension Reinforcement in Cantilever Ribs

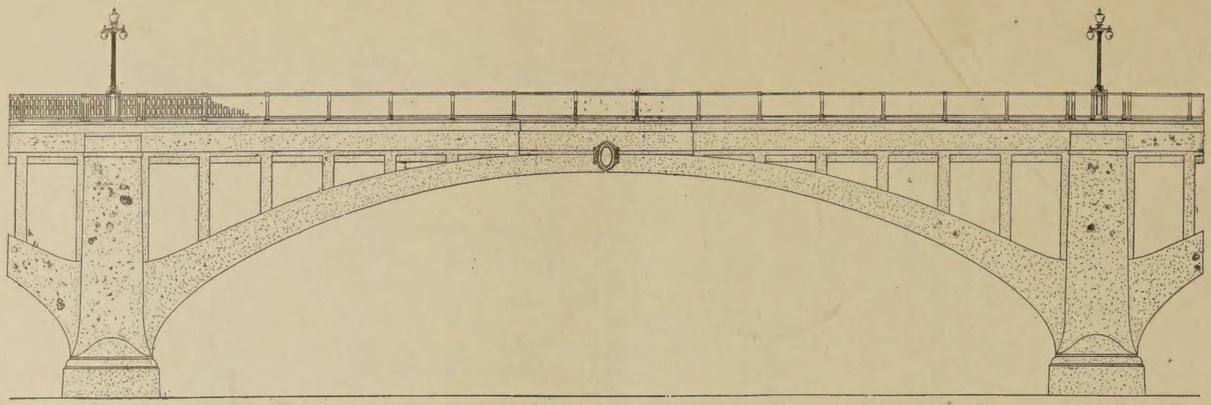


FIG. 5—TYPICAL SPAN SHOWING ORNAMENTAL TREATMENT AND RAILING AND LAMP POSTS

cantilever, the outer pin being directly beneath the bearings that support the short mid-span section.

Owing to the fact that a convenient site was available up-stream from the site of the bridge for fabricating the main sections of the reinforcement, a method was adopted that proved both economical and rapid. The double cantilever sections comprising practically one-half of two adjacent spans, from center to center of spans were erected and transported to their proper positions over the piers, on barges and then lowered into place on the foundation piers by letting water into the supporting barges.

Form supports were provided as shown in the details in Fig. 3 and on these the forms were hung as illustrated in section F-F, of the same figure. After the concrete was poured in the cantilever ribs and allowed to harden the required length of time, these ribs were used to support the form work for the rest of the superstructure.

In the end of each cantilever rib, near the center of the span a bronze casting was placed in the concrete as a bearing for the end of the plate girder that connects the two adjacent cantilevers. One end of this built-up girder was made fast and the other left free to move on its bearing so as to provide for lateral motion due to expansion and contraction in the span. The girders were encased with concrete as the remainder of the superstructure concrete was poured. A typical double cantilever is shown in Fig. 4.

The concrete piers rest on wood piles, the average length of which was over 40 ft. The tops of the piles in the main spans are approximately 28 ft. below the surface of the water.

Gravel was used as aggregate only in the substructure of some of the piers, all the superstructure concrete being constructed of crushed limestone as coarse aggregate.

H. H. Esselstyn, Detroit, was consulting engineer on the job and the concrete work was done by Greiling Bros., Green Bay, Wis. The Wisconsin Bridge and Iron Co. furnished and erected the structural steel reinforcement.

The American Concrete Institute will celebrate the occasion of its 20th Annual Convention with a splendid program and an exhibit, Chicago, Feb. 25-28, 1924.

Plaster and Stucco Investigated

During the past 10 years investigations have been conducted at the Bureau of Standards with the object not only of improving stucco but of developing more permanent and pleasing finishes of this type for residence construction. The results of this work have formed the basis to a large extent of the "Recommended Practice for Portland Cement Stucco" adopted this year in revised form by the American Concrete Institute.

In the summer of 1922 a group of 10 new experimental panels, each approximately 9 x 16 ft., was erected on the Bureau's test structure to compare the effects of various types of reinforcing lath and fabric, commonly used as bases for cement stucco. While these panels were a disappointment in respect to freedom from defects, they served to concentrate attention upon the importance of the method of attachment of lath or fabric to the supporting wood frame, and also to the value of applying and curing the stucco according to correct principles.

The suggestions from the 1922 investigation, together with a mild controversy as to the merits of sheathing versus no sheathing on stucco houses, led the bureau to plan a new investigation which might establish with greater certainty some of the questions now in dispute. Upon taking up the matter with interested associations and manufacturers, a very lively interest was shown, and as a result the cooperation of the National Lumber Manufacturers' Association, the Portland Cement Association, the Associated Metal Lath Manufacturers, and a number of individual manufacturers of wire lath and fabric has been obtained in furthering the investigation.

The work is now in progress and involves the replacement of 32 of the old panels on the stucco test building. New panels will be erected during the favorable weather conditions which usually prevail in Washington at this season, and it is expected that these will be completed before the end of 1923.

If you have a "kink" that you have used on the job, why not trade it for a new one through CONCRETE?

The Actual Uses of Alumina Cements

(Second Article)

A Record of Jobs

By Edwin C. Eckel

> Alumina cement has certain very obvious technical advantages, which appeal instantly to both engineer and contractor who have seen it in use. And the apparent disadvantage—its necessarily high cost *per barrel*—is only apparent, for Alumina cement, whatever its cost per barrel, makes a cubic yard of concrete harden in place at a lower cost than any other cement, owing to the economies possible in proportions, labor, forms and time.
>
> —Edwin C. Eckel

It has been said that Alumina cement, as at present made in France and in the United States, possesses two widely different sets of valuable technical properties; it is, on the one hand, specially resistant to chemical action, and, on the other, it attains great strength with extraordinary rapidity. As a matter of general technical interest, I may say now that there is, in my opinion, no reason why these two sets of properties should *necessarily* be associated in the same cement. Having regard to present methods of manufacture and present compositions, all good Alumina cements of the present day do possess both properties. But it is very easy to see that, by varying either chemical composition or mode of manufacture, we can readily produce an Alumina cement which will have only one of them, but which will have that one in an even greater degree than have the present products. This point is brought up because, in small-scale experimental work at various points, such results have actually been reached accidentally. It is entirely possible, and even probable, that in future we will do the same thing intentionally. So that ultimately there may be two different types of cement on the market, one developed with special regard to securing high chemical resistance, the other with special regard to securing very high strengths. There would be certain economic advantages in making such a separation of the two properties.

In a previous paper[1] details were given as to actual utilization of Alumina cement abroad in works requiring resistance to sea water, to alkaline waters, and to acids. In the present paper attention will be directed to the actual utilization of Alumina cement for works where its strength and rapid hardening were the determining factors in its selection and use. There have been so many of such utilizations in the past five years that only a few can be selected and noted here.

As in the previous paper, the work for which the Alumina cement was used is noted below, followed in parenthesis by the names in italics of the engineers or contractors responsible for the job. Any reader who is interested in the results of Alumina cement in actual use, as distinct from the results attained in a testing laboratory, may easily follow up any of these results from the data given. Again, as in my previous paper, I am chiefly indebted to the Lafarge Company for the data used.

The classification adopted below is admittedly crude, and the works are merely grouped in a fashion convenient for reference:

Hydro-Electric Works; power plants, chutes, etc., at Ste. Tulle (*Societe des Grands Travaux de Marseille, Marseille*); at Beaumont-Monteux (done by company); at Avrieux (done by company).

Water Supply Works; supply at Moulins (*M. J. Chaumette, Moulins*); canal for supply of La Ciotat (*Societe Meridionale de Travaux, Marseille*).

Mine Works; done by the following coal and oil mining companies on their own properties: *Compagnie des Mines de Blanzy*, at Montceau-les-Mines; *Cie des Mines de Graissessac*, at Graissessac; *Houilleres de la Haute Loire*, at Brassac; *Societe de Pechelbronn*, at Merkviller.

Cement Products; Alumina cement used by the following product-makers at their own yards; *Etablissements Larmanjat*, at Juvisy; *M. Felix Gautier*, at Perpignan; *M. de Vains*, at Miribel; *Comptoir de Commission*, at Paris; *MM. Nidrecourt et Buerle*, at Paris.

Building Construction; stand on Auteuil race track (*M. Chouard, Paris*); Hotel des Postes at Chateauroux (*Etablissement Sainrapt et Brice, Paris*); reconstruction of Theatre des Mathurins (*Societe Cimenrold, Paris*); repairs on Michelin factory at Clermont-Ferrand)*M. Duchereau, Paris*); storehouses for paper mills at Lyon (*Meyer et Cie, Lyon*); repairs of barracks (*Chefferie du Genie, Valence*); gun emplacements (*Chefferie du Genie, Chalon sur Saone*); repairs on sugar houses (*Raffinerie Lebaudy, Paris*); department store La Riviera, at Nice (*Thorrand et Cie, Nice*); works on the Metropolitan Subway, at Paris (*MM. Tixiere et Desplats, Nicaud et Cie, Billiard et Marchand*—all contractors of Paris; foundations, etc., for Cie d'Electricite, at St. Denis (*M. Chouard, Paris*).

Bridges, etc.; bridge at Tonneins (*MM. Limousin et Cie, Paris*); caisson for bridge work at Collias (*Soc. des Grands Travaux Hydrauliques, Toulon*); barrage at des Farguettes (*Soc. d'Entreprises et d'Exploitations, Paris.*)

Tramways; used by *Metropolitan Subway* in Paris, and by street car lines of the *Societe des Transports de la Region Parisienne*, at Paris; and by the *Cie. O. T. L.*, at Lyon.

Railways; railway stations at Aulnoye (*Etab. Sainrapt et Brice, Paris*); at Lille (*same firm*); at Tergnier (*Soc. des Travaus en Ciment Arme, Paris*); locomotive house at Chatou (*MM. Lauboeuf et Billet, Chatou*); maintenance of way on Etat Railway (*M. Cognault, chief engineer*); various railway works in North Africa (*Cie. du Chemin de Fer de Tanger a Fez*); extensive works in southern France (*Chemin de Fer Paris-Lyon-Mediterranee, Paris*).

Street Repairs, etc.; practically all the cement used in Paris on street foundation and repair work is now Alumina cement. This work is done under city control, and *M. Michel, Chief Engineer, City of Paris*, has been in charge during the period.

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[1] Concrete, November, 1923, page 175.

The list of works and addresses above given could be extended greatly, but nothing would be gained by such procedure. I have merely selected, very much at random, from a super-abundant supply of data along these lines, with the idea of getting works fairly distributed both by character of work and by location—so that any reader can carry the study to completion along his own lines and to his own satisfaction. In doing so he will, I believe, come very quickly to the conclusion that Alumina cement is not a new and untried material, but that it has a record of some five to fifteen years of actual successful use in various types of work. It has certain very obvious technical advantages, which appeal instantly to both engineer and contractor who have seen it in use. And the apparent disadvantage—its necessarily high cost *per barrel*—is only apparent, for Alumina cement, whatever its cost per barrel, makes a cubic yard of concrete harden in place at a lower cost than any other cement, owing to the economies possible in proportions, labor, forms and time.

As to the place which the new industry will take in the United States, it is as yet too early to get a fair idea. What we do know now is that the American market offers the same possibilities for a cement of this type as do the foreign markets, but on a far larger scale; that there are no economic disadvantages which will retard its manufacture here; and that the Alumina cement that has been actually made in America gives results superior, in strength tests, to those of standard foreign brands. The new industry has no financial limitations to retard its progress; and under these favorable conditions it may develop very rapidly. An American output of ten million barrels in 1928 does not seem too difficult a mark.

Unusual Plant for Concreting Astoria Apartments

By W. S. Hood
Portland Cement Association, New York City

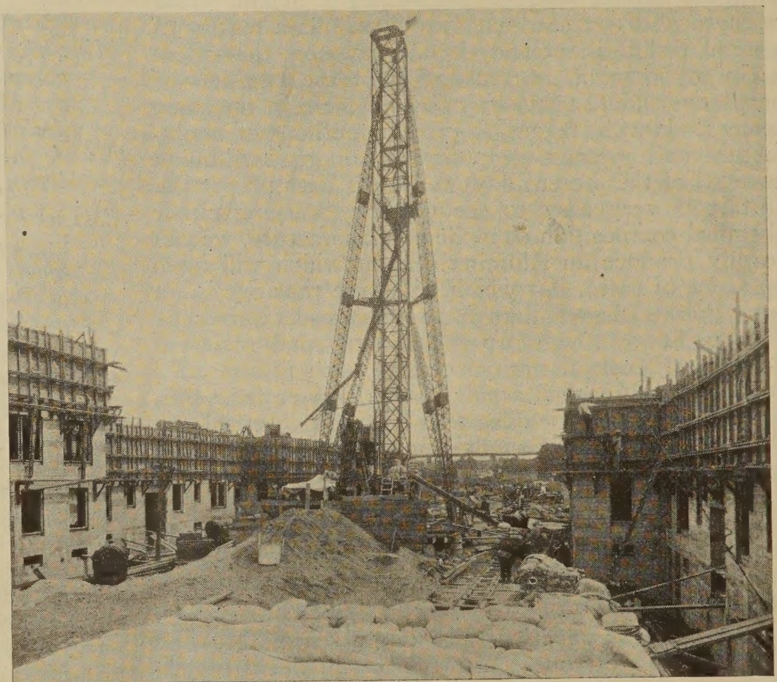


Fig. 1—The Portable Concreting Plant with 140-ft. Tower, Used by American Concrete Steel Co. in Concrete Apartment Construction

Concrete apartment houses of reasonable cost and with an attractive appearance are being built in quantities for the Crescent Development Co., 120 Broadway, New York city, in that part of Astoria, Long Island, adjacent to the Hoyt Avenue station of the Astoria Subway, and only twenty minutes from Grand Central Station.

The entire plot being developed covers six blocks. Contract has been let for 51 of 180 buildings, shown on the accompanying block plan. They are 49 ft. 11 in. x 43 ft. 8 in.—four stories and basement with individual heating system, each building containing nine apartments varying from three to seven rooms. Rooms are good size, i.e., living room, 12 ft. 9 in. x 14 ft. 11 in.; dining room, 11 ft. 0 in. x 15 ft. 0 in.; chamber, 11 ft. 0 in. x 13 ft. 0 in. A typical plan is shown.

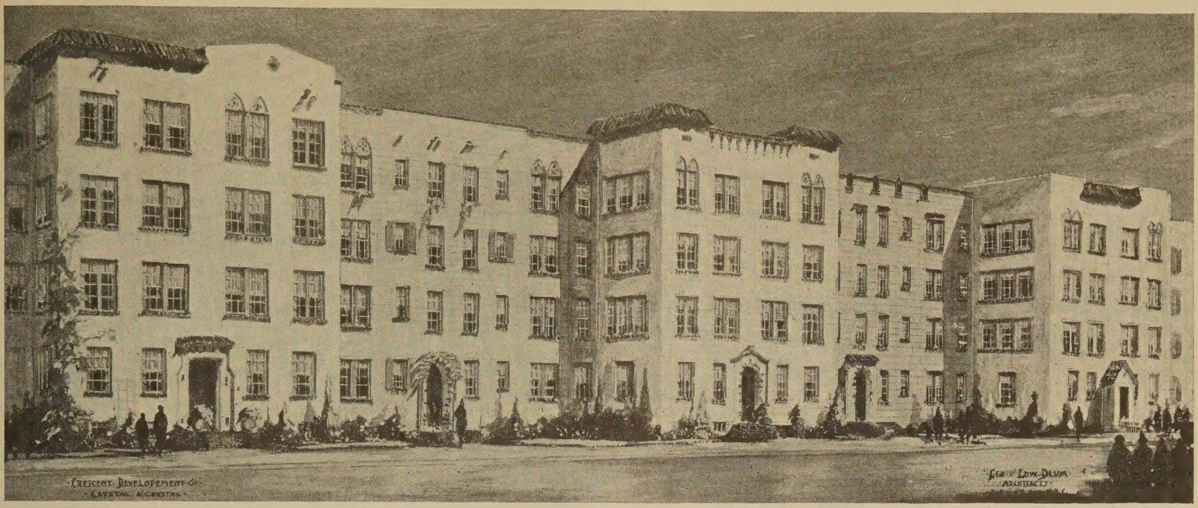
The plot plan shows the location of the apartments and the large air space between the rear of the buildings, which will be landscaped into playgrounds for children and for flower beds, etc. Between the sidewalk and the front of the buildings is a well-sodded grass plot.

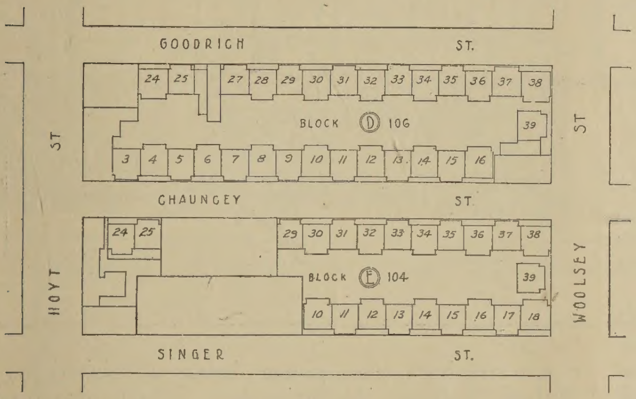
The basement walls are 16 in. wide, double reinforced with ⅜-in. rods. Above grade line to roof, the walls are 12 in. thick. The exterior is left plain, showing the joints or form board marks, which are accentuated by washing down the wall and leaving these marks to stand out.

The wooden window frames are set in the wall forms and poured in place. These have sills of red brick for decorative purposes.

There are six different types of entrances which are used throughout, for individuality in each building. Entrance characteristics are:

1. Interior—Brick wall to sill height. Sill height to ceiling P. C. Stucco on brick, with brick inserts studding the wall. Exterior—Stucco.
2. Interior—All brick. Exterior—Concrete arch with irregular brick inserts.
3. Interior—Brick to sill heights of crazy quilt pattern. Stucco above, with brick inserts. Exterior—Concrete Gothic arch, with brick trim.
4. Interior—Brick. Straight courses below sill height. Sill height to ceiling—crazy quilt pattern. Exterior—Arched concrete with a tile insert on each side.
5. Interior—Plain brick. Exterior—Stucco on brick, with brick





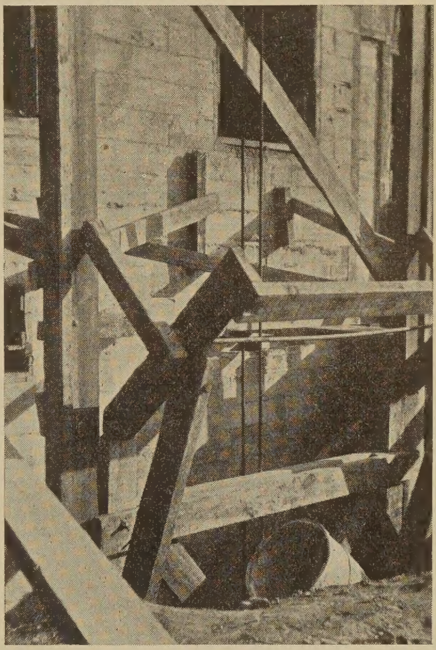


Fig. 2—A Typical Perspective of a Group of the Crescent Development Co's Concrete Apartments, Astoria, Long Island —George and Edward Blum, Architects

Fig. 3 (Right)—Simple Elevator for Forms and Floor Joists, Saving Much Hand Labor

Fig. 4 (Above)—Block Plan of Crescent Development Apartments Being Completed at this Time. Six Blocks are Included in the Whole Undertaking

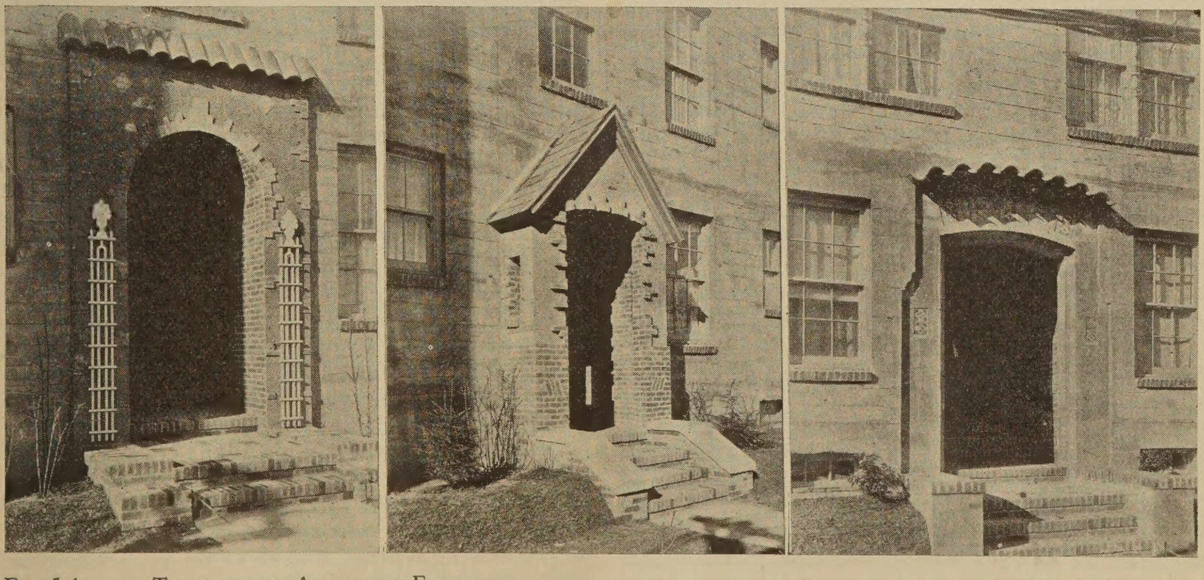


Fig. 5 Above—Three of the Apartment Entrances

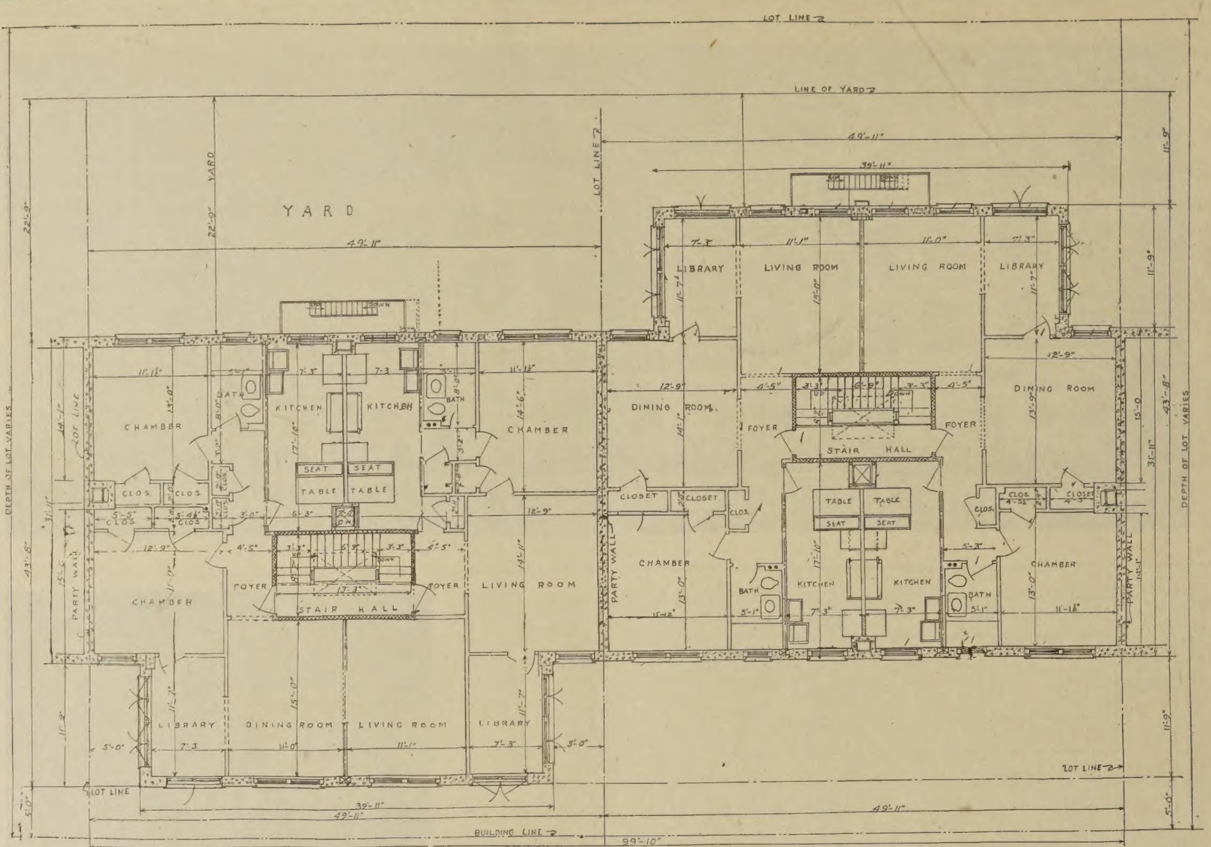


Fig. 6—Typical Apartment Plan

trim of varying sizes. Small steep roof, with varied colored asbestos shingles.

6. Interior—Brick below sill height. Crazy quilt pattern. Horizontal courses above. Exterior—Concrete arch, with a tile insert on each side and four in header. Half tiles project from above.

The parapet walls are also of six different types. Spanish tile has been used as a decorative unit.

Floor beams 3 in. x 8 in. are laid with 6-in. bearing, 4-in. fire cut, and 2-in. fire stop. On these are placed the rough flooring, ¾-in. x 4-in. diagonal pine flooring. Finished floor of ⅞-in. oak.

Entrance hall floors and stair landings are of 4-in. cinder concrete arches with slate top. These are left in a rough state to give the effect of seventeenth-century old English houses. Stairways are of steel, with precast concrete slab steps.

Partitions are of plaster on wood studding, with the exception of the hallways, which have tile partitions, and the meter room in the basement, which has concrete walls, thus protecting the remainder of the house from possible explosions. The dumb waiter shaft is of concrete to first floor and of gypsum blocks above.

The houses are attached, and have a fire passage in basement of each building leading from rear yard to street. The rooms are large, all have good lighting, and the kitchen and bathroom fittings are of the best modern design.

A feature is the heavy 3-in. chestnut exterior doors, which also lend a medieval touch to the buildings. The wood was chosen full of worm holes for this effect. Steel fire-escape brackets are held in place by bolts with 4-in. hooks inside of the wall.

An interesting feature of this work from a contractor's point of view is the portable, one-yard concrete plant. This outfit was designed by J. R. Shore, general superintendent of the American Concrete Steel Co. and E. G. Robinson, of the R. E. Brooks Co.

A one-yard Koehring mixer is driven by belt from a countershaft, the power being furnished by one central 75 h. p. electric motor, which also operates the hoist for the tower.

A 140-ft. Insley steel tower, with a 50-ft. boom and 50-ft. counterweight chute, was mounted on a 30-ft. x 30-ft. platform supported on sixteen 30-in. flanged wheels. The track, which was laid 60 ft. in front of the outfit, made it as easy to move as a freight car.

The tower, even though 140 ft. high, was entirely self-supporting without the use of guys while being moved. This was accomplished by using four steel stiff legs.

The concrete was elevated to the proper height, and the chutes carried it to the forms on both sides of the street, where the buildings were carried up simultaneously. A sliding frame attached to the tower enabled the chutes to be raised or lowered as required, to secure the proper pitch to deliver the concrete into forms. The buildings are 850 ft. long on the main street, and 50 ft. high, with a depth of 50 ft., and the same equipment was used to pour a single row of houses in each of the adjoining streets by elevating the chutes to the 100-ft. elevation and chuting over the completed structures.

All concrete is mixed in this central plant and conveyed by chutes to subsidiary towers, four in number, where it is again raised high enough to distribute over the buildings. The reach of this system can be appreciated on the pouring of the farthest work. Concrete is chuted 350 ft. from main plant to a second tower, 100 ft. high, from which it is again spread to a radius of 150 ft., giving a total of 500 ft. carry from plant.

The aggregates were placed by motor trucks on one side of the main plant, and elevated by means of bucket conveyors to a bin of 20-yd capacity over the batch hopper of the mixer, a drag line scraper being used to keep the elevator boat filled. The cement was con-

Figs. 7-8-9—The Apartment House in Progress. In the Top Picture—1, Main Hoist Tower; 2, Stub-Tower Supporting Hopper of Line Chute to Rehoist Tower at Opposite End of Street; 3, Rehoist Tower; 4, Stub-Tower Supporting Line Chute from No. 1 Tower to Buildings at Eastern Side of Group

veyed by industrial cars, and elevated by a belt conveyor to a platform on a line with the batch hopper.

The work has been carried ahead with from three to four buildings as a unit, and at the end of each unit an expansion joint is carried up the full height of exterior walls. This is a 6-in. recess, the thickness of the wall with key, and surface painted with Minwax. A 4 in. x 10 in. recess is also left in wall for floor beams of succeeding buildings.

A device for elevating roofers, floor beams and other lumber has been rigged up at the instigation of Gus Johnson, superintendent. A vertical frame was built the full height of the building, using 2-in. x 10-in. guides about 8 ft. on centers and cross braced. The carriage sliding on this frame has its carrying member at 45° from the vertical, and is about 5 ft. long. This is back braced against the slides. An electric double drum hoist raises the load to the floor of roof, and the material slides off automatically. This saves two men's wages unloading, and the initial expense is but a trifle in comparison to savings effected.

The architects on this project are George and Edward Blum, 505 Fifth Avenue, New York City. Engineers and contractors, American Concrete Steel Co., 33 Clinton Street, Newark, E. C. Epple, chief engineer; J. R. Shore, general superintendent.

Heavy-Duty Concrete Floors

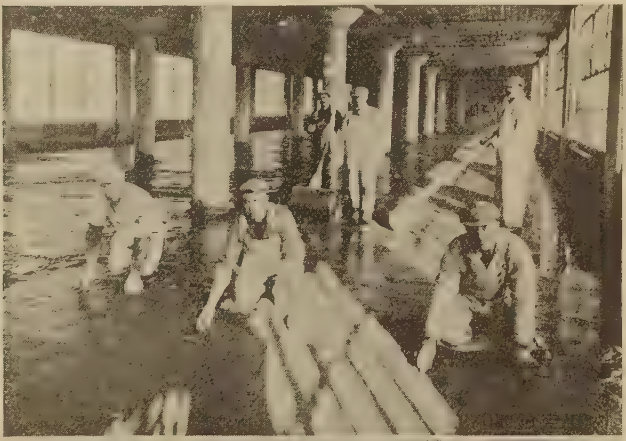
By W. E. Hart

Manager, Structural Bureau, Portland Cement Association

The attractive appearance of terrazzo floors has long been recognized, but the use of this type of polished floor for industrial buildings is not so well appreciated.

The following is a description of the method followed in laying a heavy-traffic floor in an eastern shoe manufacturing plant. This floor is subjected to the action of very heavily loaded steel-wheeled trucks, and the method of construction was adopted after tests were made of the wearing qualities of the floor, severe conditions of test having been applied to the type selected as well as to several other types. The tests are described more fully in another part of this story.

When the actual floor was built, following the tests, the rough slab was first picked, swept and washed with clean water. One-inch round steel bars were then



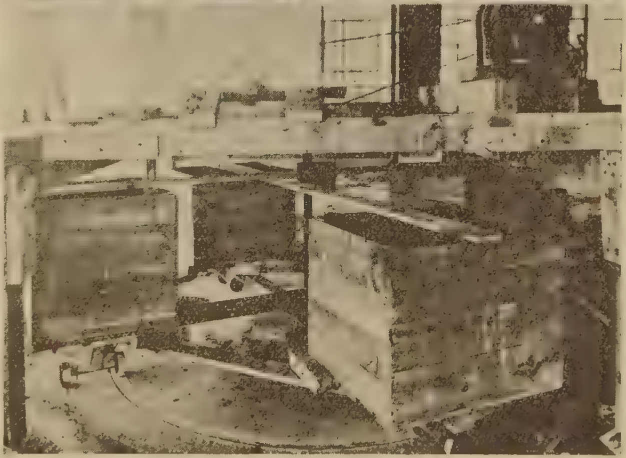


Fig. 1—"Finishing a Heavy Duty Floor

Fig. 2—How Tests Were Made

placed as grounds and leveled up. The floor was again wet down and a 1:1 cement-sand grout brushed on. Before the grout had set a 1:2 mixture of cement and trap rock uniformly graded from ⅛ to ¾ in. was dumped on the floor and screeded off. The mixture was as dry as it was possible to dump out of the mixer. The grounds were then removed and the spaces filled with the 1:2 mixture.

Just about the time when the topping material was stiffening up, an even coating of crushed trap rock was spread over the entire surface to a depth of ½ to ¾ in. and rolled into the surface with a 150-lb. concrete roller. This roller was operated longitudinally and laterally until the entire area had been evenly rolled. A 900-lb. roller was used next, and last of all an 1,800-lb. roller was operated laterally, longitudinally and diagonally. This last rolling brought up some water and fine material to the surface.

As soon as possible after the final rolling the floor was given a hand steel troweling sufficient only to smooth out any of the stone that had been upended by the rolling processes. Twelve men were able to trowel about 15,000 sq. ft. of floor in two hours.

As a final operation the floor was ground with ordinary grinding machines that utilized carborundum block and coarse powdered emery with a generous supply of water. The grinding operations were started from four to seven days after the topping had been placed.

After more than two years of severe trucking these floors are in excellent condition, and due to the smooth and even surface, the trucks do not produce the usual heavy rumbling. This type of construction also appears to hold great promise of solving the problem of floor construction in ice cream factories, packing plants, etc., where the floors are subjected to the action of lactic, butyric or other weak acids in addition to truck traffic.

Mention is made above of the tests carried out to determine the best type of floor to lay. Prior to the construction of the floors in this large plant, which required approximately 210,000 sq. ft., the engineer in charge of construction devised and constructed the testing machine shown in an accompanying illustration.

Samples of three types of construction were laid out and the testing machine was set up over them. This machine consisted of a vertical shaft driven by a worm gear and motor. Attached to the shaft is a spider consisting of four arms, each one in turn having at its extremity a box running on a single two-wheel truck. These wheels were of steel, 5 in. in diameter, with a 1¼-in. face. Each box over the trucks was loaded to carry approximately 500 lbs. After the boxes were loaded the machine was made to revolve at the rate of about 15 revolutions per minute.

By this method of test the engineer was able to ascertain the relative merits of various types of floor construction. The one described above withstood by far the greatest number of revolutions and was the one finally adopted as the type to be used.

The reason for adopting this type of testing machine was that it approached the traffic conditions to which the floors in the company's proposed new building would be subjected. In their factory certain portions of the floors must withstand concentrated traffic from hand trucks. The engineer found that this series of tests paid big dividends, because by abiding by the results obtained he has been able to reduce his floor maintenance costs to a minimum.

Reinforced Concrete Proved Its Efficiency in Japan

By T. Okubo
Tokyo, Japan

In very few words T. Okubo, of the Truscon Steel Co. of Japan, gives his fellow readers of Concrete a statement of what happened to various building materials, various types of construction and the results of good and bad workmanship, under the severe test of quake and fire. In his letter to the editor of this magazine, we feel that a part of his message is an acknowledgment and an appeal to America:

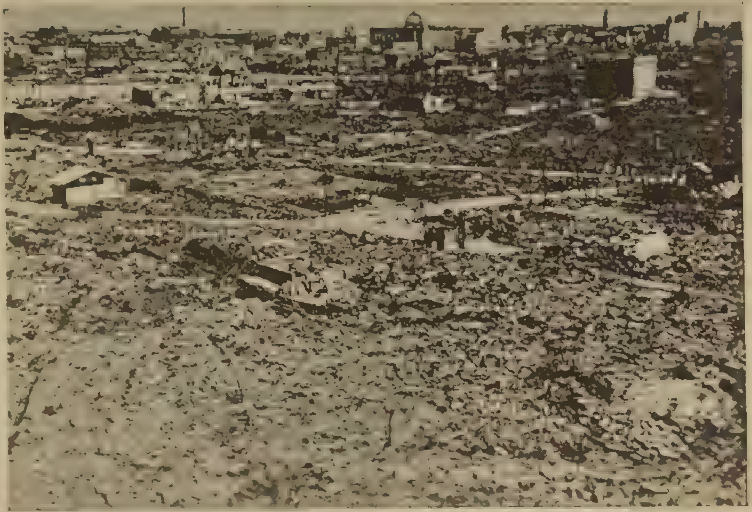
"I like to show my great appreciation of your sympathy which you sent us so promptly and liberally for our distress caused by the unprecedented event. We are now striving to rebuild our desolated towns with all our effort, and I wish you would give us further help by sending us necessary materials and technical advice."

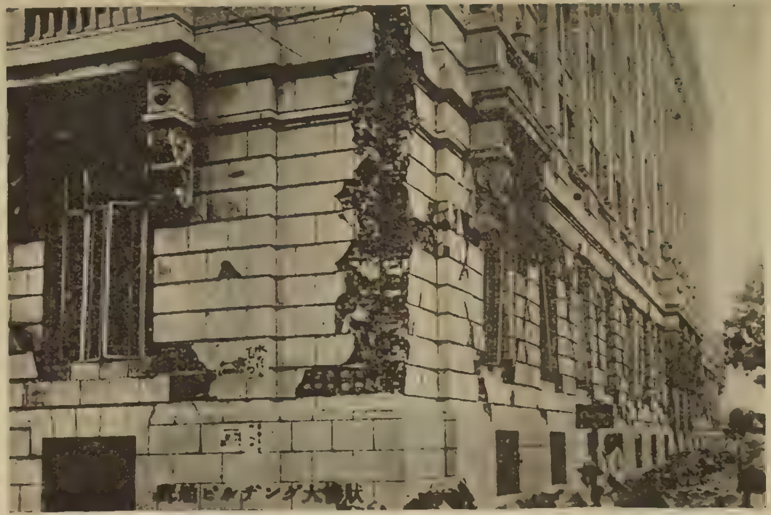
We have learned a great many lessons from the unprecedented disaster wrought on the Japanese capital, September 1, 1923. More than a hundred thousand lives were lost, and the property destruction amounted to $5,000,000,000. (Figs. 1 and 5 give the general idea of the devastated areas.) This is too high price to pay again for such an experiemnt in construction, and we should not have such havoc repeated. Authorities on seismology have been advising the people for some time to have an efficient and safe fire system in our capital city, anticipating the big fire in connection with an earthquake which was expected someday. It came too soon.

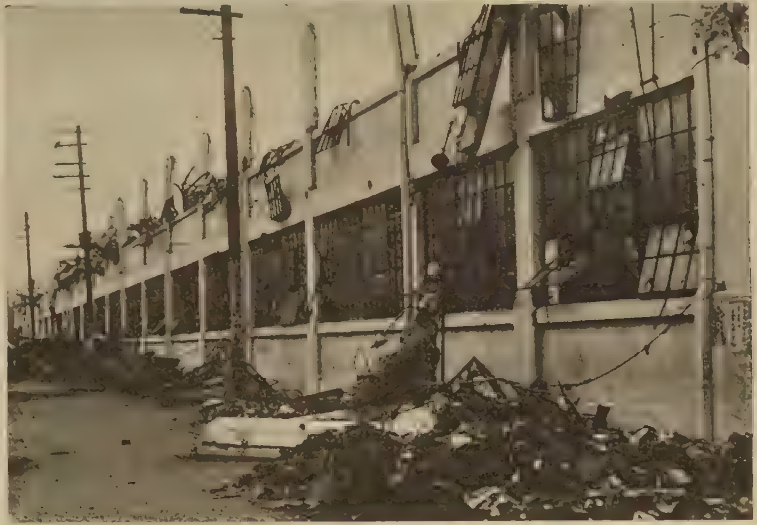
Having been responsible for the design of many buildings in the earthquake zone, it is natural that I availed myself of this opportunity to study the effect of the earthquake and fire on various types of building construction. It is once more brought out before us that the truly fireproof building should, at the same time, be made quake-resisting, and the truly earthquake-proof building should always be fireproof.

Wooden buildings faced with tile or stucco meet their natural fate. At the moment of the first shock, these coverings were shaken off in pieces; the wooden lath beneath exposed to the free attack of the fire and the whole building was consumed after it came through the earthquake.

It is well known that the wooden frame buildings are very elastic and shock-proof, provided they have







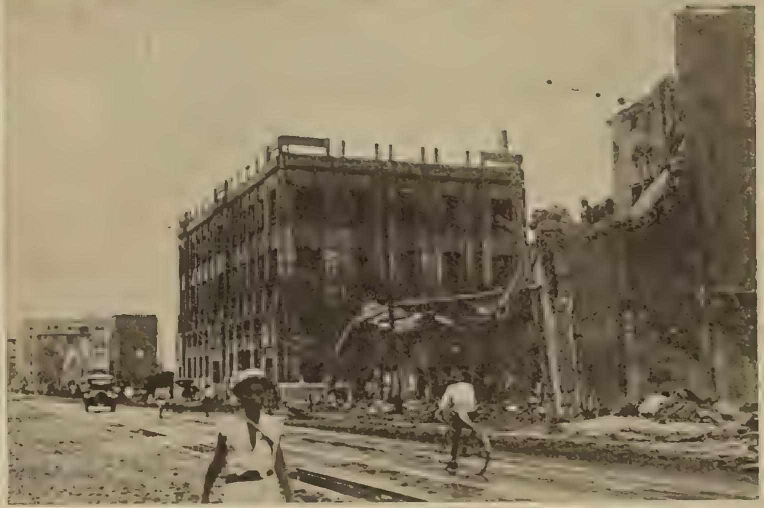
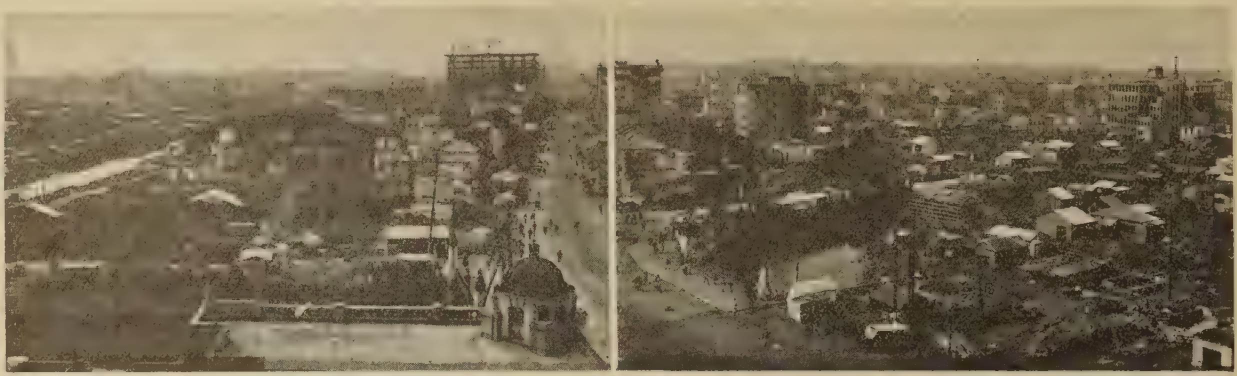


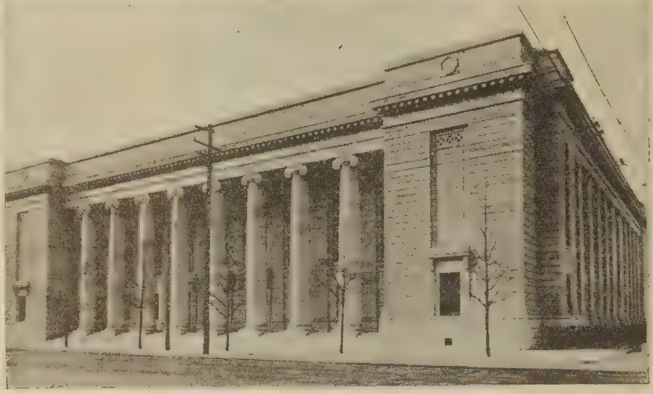
Fig. 1 (Upper Left):—A View of Tokyo One Month After the Fire, Showing Wooden Barracks on Burnt Area

Fig. 2 (Upper Right)—Yusen Building After the Quake Showing Heavy Damage on Terra Cotta Finish on Brick Wall Exposing Steel Column

Fig. 3 (Lower Left)—Factory of Nippon Electric Co.

Fig. 4 (Lower Right)—Kawasaki Bank Building. Concrete Work Only Being Finished at the Time of Quake. Collapsed Maruzen Company Building in Foreground Which Was Steel Frame Building with Concrete Floor





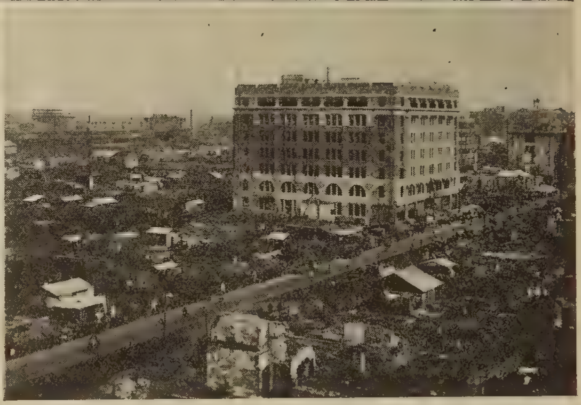


Fig. 5 (Top)—A View of Yokohama Totally Destroyed by Fire

Fig. 6 (Lower Left)—Mitsubishi Bank Standing in Perfect Condition After the Earthquake, Representing Many Well Laid Stone Buildings

Fig. 7—Chiyoda Life Insurance Company Building All Concrete Building with Granite Facing for Lower Section and Facing Tile for Upper Section. Granite Was Badly Chipped by Fire

fitted joints and are structurally sound. This fact was proved positively by the last earthquake, and such buildings will continue to assume the position of one of the best types of buildings to be erected in earthquake zone when money available is not enough to build more permanent structure. But, unfortunately, they are not fireproof construction. They are not only powerless against fire by themselves, but they endangered the higher class buildings when they were crowded around such buildings, even though those costly buildings of fire-resisting material were equipped with shutters and other fireproofing devices. Consequently the wooden houses should not be allowed in the downtown district.

Well-laid stone building suffered very little damage from earthquake (see Fig. 6), but in the district swept by fire, all granite facings were shamefully damaged.

The stability of brick walls seems to depend greatly on the workmanship and quality of brick and mortar. Nearly all brick structures in Tokyo and Yokohama came down, excepting a few monumental and costly buildings. These failures came so suddenly, without warning, that a large number of people were killed as they collapsed. No more brick buildings should be permitted in an earthquake zone when we can get other suitable material for fireproofing purposes for which the brick was originally devised.

Steel frame structures protected by reinforced concrete wall, where well executed, came through with practically no damage. But those with brick curtain walls or terra-cotta facing suffered severely, as did hollow tile partitions. Figs. 2 and 8 give good examples of this kind of failure.

Reinforced concrete buildings, where well proportioned and honestly executed, stood the test admirably, and their superior quality, both as shock-resisting and fireproofing material, was proved conclusively.

About 300 buildings of this type existed in Tokyo before the earthquake. More than 200 out of these came through both earthquake and fire without any

(Continued on page 243)

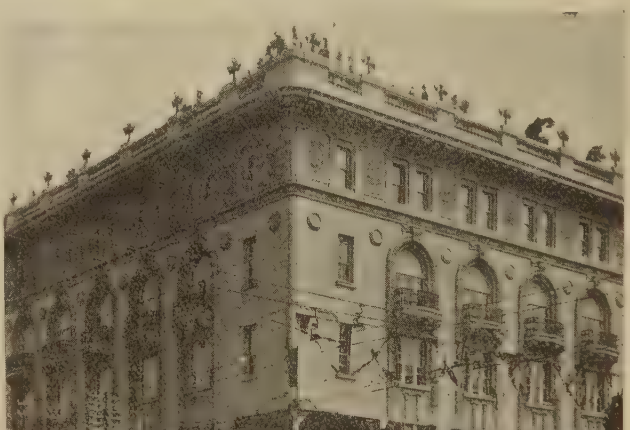


Fig. 8—Palace Hotel of Tokyo Brick. Wall on Second Floor Entirely Came Off and Steel Columns Deflected More Than 6 In.

Combined Reinforced Concrete and Mill Construction

By K. D. Hamilton
Mechanical Engineer, George E. Keith Co.

Abstracted from an article in *Factory, the Magazine of Management.*

Immediate expansion of its production equipment was the problem which in 1920 faced the George E. Keith Co., manufacturers of the Walk-Over shoe. This concern maintains factories in five cities and since the plant consists of buildings of different types, its experience in shoe factory buildings has been extremely broad.

It was still felt, however, that the perfect shoe factory had not as yet been developed, as there was a tremendous amount of waste room and non-productive space in the older buildings. The lighting system was not what it should be, and the routing of shoes, together with the handling of raw materials, could be improved upon.

The typical shoe factory and, for that matter, factory buildings in many another industry, consist of a long, narrow building from 35 to 45 ft. wide, with a row of machines near the windows, leaving the interior of the factory for storage of shoe racks and other miscellaneous work. This storage space is waste room in one sense, as it cannot be entirely utilized to the best advantage.

The engineering department of this company conceived the idea that if sufficient light could be thrown into the middle of the room, and the building made of a design of proper width, it would be possible to utilize this interior space for production purposes. This would increase the capacity of the factory per square foot, and reduce the overhead per pair of shoes.

After much experimenting and investigation it was finally decided that a building 60 ft. wide, with sufficient window area, could be utilized to good advantage, having working aisles of 20 ft. with one row of machinery in each aisle. This radical change in shoe-factory design required the utmost care in detailing and routing the shoes through the building, so that there would be no conflict or interference of materials. It also necessitated the use of three elevators, so that the work could be handled with the least amount of effort from one department to another.

The size of the building which was finally accepted consisted of a structure 400 ft. long, 60 ft. wide, four stories and a basement, with a wing 60 ft. wide and 80 ft. long of the same height. It was decided to place the toilet rooms, coat check rooms, emergency rooms, rest rooms, elevators, restaurant and miscellaneous departments, in the wing—maintaining the main structure as a long thoroughfare free from all obstructions, so that the work could pass through the building in straight lines, and thus eliminate the unnecessary handling of materials.

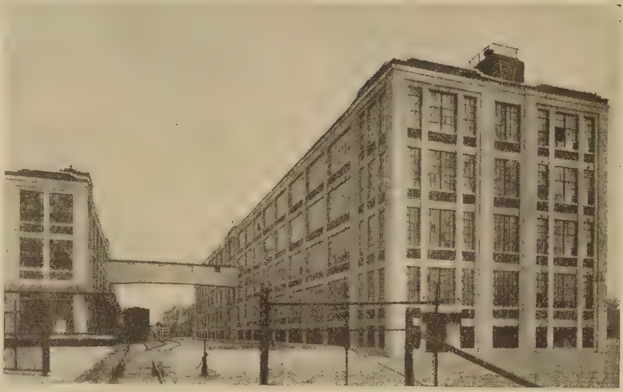


Fig. 1—How the Two Buildings Compare on the Outside. At the Left is a Typical Reinforced Concrete Structure, While on the Right is a Building Containing Both Reinforced Concrete and Mill Construction

The method of construction was perfectly obvious, having first determined the size and shape of this building. It was absolutely essential to have a maximum amount of daylight in the interior of the room. The only type of construction which would afford large windows was the reinforced concrete exterior frame. It has been the experience of this company, however, that a wood floor throughout is the perfect floor for a shoe factory, for the several reasons pointed out in the following sections. This necessitated deviating from the typical reinforced concrete structure to that of a building consisting of exterior walls of reinforced concrete, with interior frame and floors of wood.

This method of construction was somewhat novel, especially as that adapted to a building 60 ft. wide. Hard pine posts and timbers were spaced in 10-ft. bays throughout the building, except on the top floor, where the spacing was increased to 20 ft.

This daylight factory required the maximum amount of window area, and, therefore, it was found impossible to space the pilasters on the exterior walls

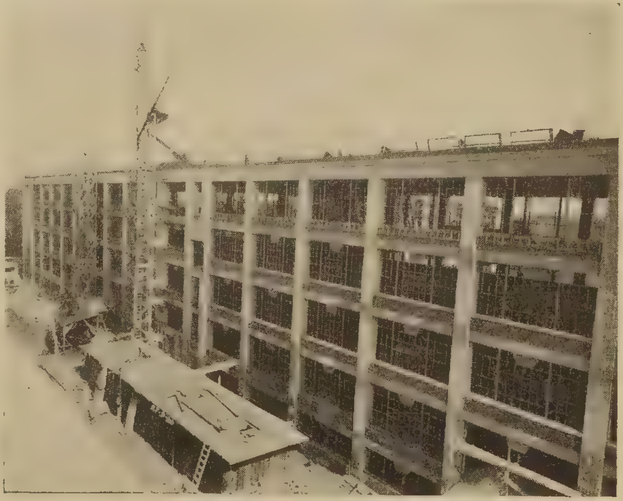


Fig. 2—Construction of Concrete Exterior with Interior Frame and Floors of Wood

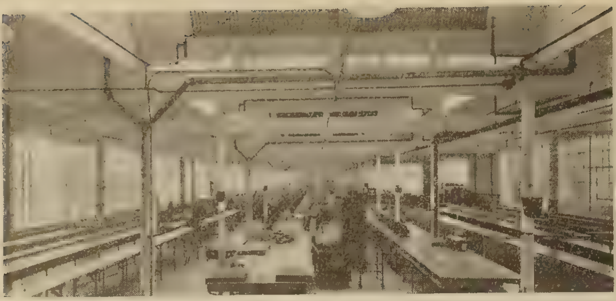


Fig. 3—Interior View of Top Floor Showing Interior Framing and Saw-Tooth Roof

at the customary 10-ft. intervals. A 20-ft. exterior bay was determined upon, and a method devised to hang the alternate girders to the concrete lintel, between the exterior pilasters. This girder rests on top of the lintel or is supported by the pilaster in the ordinary type of building and results in a smaller window opening. It was finally decided to hang this girder on the bottom of the concrete lintel by means of a special built-up steel hanger. The installation of this hanger made it possible to obtain 18 in. of additional window area, at the ceiling level, where light was most valuable.

It is well understood that the light transmitted through a window is deflected a greater distance to the interior of a building from the ceiling level. By raising the concrete lintel so that the beam could be supported in this manner greater efficiency was obtained from the windows, and the light transmitted further into the center of the building.

Fig. 2, illustrating the exterior of the building during construction demonstrates this principle perfectly, and brings out the advantage of this method of construction. This system of construction adapts itself admirably from the contractor's point of view, as the interior frame can be carried up with the exterior walls, using the floors to good advantage in placing the concrete. This eliminated all staging and other temporary scaffolding, which is so common in a concrete building or other structures of this nature.

The floors in this building consist of 4-in. hard pine tongue-and-groove plank, securely spiked to the hard pine girders, upon which was nailed a middle floor of hemlock, to receive the matched maple wearing surface as a finished floor. The middle floor was necessary so that the maple top could be laid in the proper direction to receive the trucking of the material, which travels lengthwise of the building.

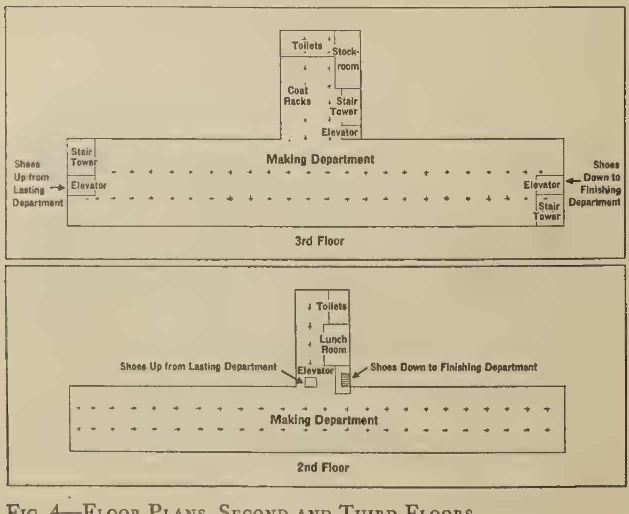


Fig. 4—Floor Plans, Second and Third Floors

The experience of this company has found it absolutely necessary to use a wood floor. The reason for this method of construction is that the shoe factory machinery is moved about from time to time, due to the changes in style and methods of manufacture. This necessitates an easy method of attaching machines to flooring, and also provides the flexible means of changing pipe lines, electrical conduits, motors, and other equipment which is secured to the floor.

The finished building is illustrated in Fig. 1, following the typical lines of reinforced concrete construction with steel sash. The interior views, however, bring out the practicability of the wood columns, girders and floors.

The experience of the last three years has borne out the assumptions made when the design of this building was first conceived, and it has proved to be one of the most practical shoe factories that has yet been built. The design and layout of the machinery, together with the various lighting, heating, power transmission, and other systems, were carefully studied before the adoption of the equipment finally installed. This particular building was built and designed around the machinery plan. In most instances the building is first constructed, and the machinery fitted to the building. The common practice of constructing the factory and adapting the machinery to the structure often results in expensive alterations and inefficient production methods.

The important feature in all of the designs was to obtain the maximum amount of daylight at the interior of the building, and the equipment was perfected with this point in mind. The cutting and stitching rooms were located on the top floor, where a large saw-tooth as shown in Fig. 3, was installed to give daylight service in all portions of the room. Benches, partitions, and all office work, were kept at the eye level, so that the foreman could see to all parts of his department. Individual lighting was furnished to the power tables on brackets attached to the tables themselves, thus eliminating all drop cords and other electrical apparatus which is so unsightly in a large room, where many sections of power tables are employed.

A small amount of general illumination was provided for this room, and all circuits are controlled from central power panels. General illumination was used on each floor, which eliminated the customary drop light so common in the typical shoe factory. This was accomplished by the use of white ceilings, and large reflecting areas, transmitting the light to the work.

Power and lighting transmission throughout the building is extremely complicated, as each machine was wired for an electric motor. All wiring was in conduits, and the most up-to-date methods adopted. A central switchboard is located in the mechanical equipment room in the basement, which controls all the main circuits through the various floors. Each department is separately metered on the distributing panels throughout the floors, so that the power cost can be charged to each room.

The dust-collecting system, which in the typical shoe factory is hung on the ceiling of the various floors, is placed on the outside of the building, thus eliminating the unsightly air ducts which interfere with transmission of light from exterior windows and leaves the room free from obstructions.

The exhaust fan and dust collector is located on the roof, away from the remainder of the equipment, where it can be carefully maintained and efficiently operated.

The heating system in this factory was carefully designed and has always functioned to perfection. This system is operated on a thermostatic control, which insures constant temperature at all periods of the year. The system designed was a direct vacuum heating installation, with cast iron wall radiation.

The welfare of the employees has been given proper attention in the design of this structure, providing rest rooms, emergency rooms, restaurant, most up-to-date and modern sanitaty equipment, and other features which are in keeping with the building.

A very serious problem was developed in the way of glare and extreme light through the use of large windows when operating on white or very exacting work. This was overcome by the installation of curtains as shown in the accompanying illustrations. The problem of placing curtains on steel sash with pivoted ventilators is a real one. The results obtained in this factory have been very satisfactory, both from the light control and from the maintenance angle.

The results accomplished in designing and planning this factory, after three years' experience, have proved that the original idea was correct. It is perfectly possible to utilize the interior of a modern reinforced concrete building on high grade and intensive manufacturing problems by the correct design and utilization of proper lighting effects. In this way it is possible to increase the units of output with the same amount of overhead expense. This result is only possible, however, by careful engineering, investigation and design.

The system of machines, the routing of materials, and production problems must be first thoroughly determined and planned before the building is constructed.

We believe this structure has proved conclusively that the building cannot be constructed first, and production problems solved afterwards. The building must be fitted and designed for the work to which it is applied, just as much as a machine is designed to perform a certain operation.

Why Should Wood Joists or Brick-Bearing Walls Be Used in Modern School Buildings?

By A. R. Reilly
Department of Buildings, Board of Education
Rochester, N. Y.

The three types of buildings for which separate drawings were made recently by the Rochester Board of Education furnish a basis for interesting studies of school house construction. Each of the three sets of drawings calls for a two story building with accommodations for the same number of children.

Official bids were received by the Board on June 8, 1923 as follows:

	Cubage	Total Amount of Low Bids Without Addition	With Addition
Design No. 1	1,245,917	$411,577.50	$.........
Design No. 2	1,245,917	435,252.01	513,016.41
Design No. 3	1,396,265	444,187.70	581,334.15

Design No. 1. Wood joists and floors in classrooms with fire-resistive construction in corridors, stairhalls, and toilet rooms; exterior and interior walls brick bearing; hollow gypsum tile partitions between classrooms and around flues; steel beams spanning classrooms transversely at the center of rooms and under gypsum partitions; No. 24 gauge tin-pan concrete slabs for corridor floors; roof over corridors as well as classrooms wood construction; excavation of approximately 5 ft. 0 in. under the entire first floor which space is used for steam and hot air pipes to keep the floor warm in winter.

Design No. 2. A reinforced concrete skeleton supporting walls and floors; exterior walls hollow clay tile veneered with face brick; interior partitions hollow gypsum tile except in stair towers which are enclosed in solid gypsum tile; assembly hall structural steel skeleton with fireproofing of hollow gypsum tile and brick; "one-way" gypsum tile floors; excavation under entire first floor similar to design No. 1.

Design No. 3. An embodiment of ideas of a consulting architect who was employed by the city of Rochester to suggest some means by which the cost of school buildings might be reduced—brick bearing exterior walls with a reinforced concrete skeleton supporting the interior, except the assembly hall which is similar to design No. 2; intermediate column along the corridor side of classrooms; first floor laid directly on the ground with a space for pipes in the attic and concrete plenum chambers below first floor for ventilation.

All reinforced concrete of designs Nos. 1, 2, and 3 is designed in accordance with the Joint Committee rulings of July 1, 1916, with a few exceptions which are considered ultra-conservative. The live loads of 70 lbs. per sq. ft. for the classrooms and 100 lbs. per sq. ft. for assembly halls seem excessive according to the growing opinion on the subject. However, this department has made a study of the effect of the physical exercises carried on in our classrooms and assembly halls and is convinced that school buildings should be designed to safely carry these loads.

Although the light No. 24 gauge tin-pan slabs were called for in the corridors of design No. 1, it is considered that this type of construction is not good. The pans collapse under ordinary pouring conditions, allowing concrete to run in on metal ceiling lath, increasing loads allowed for in the design, wasting concrete, giving variations in joist widths and fireproofing, and very often causing honeycomb conditions. However, the heavier cross-ribbed pans were allowed to be quoted upon for designs Nos. 2 and 3. In many cases the metal ceiling lath used in connection with tin-pan construction is subject to considerable corrosion before plaster is applied.

Contractors were allowed to quote two-way tile floors as an alternate in designs Nos. 2 and 3. Although the figure on design No. 3 was not as favorable as on design No. 2, the reason is very evident. The slabs, having no restraint and only simple bearing at exterior walls, require an additional moment factor, involving thicker slabs and heavier reinforcement. The figure for two-way tile floors on design No. 2 was not received with the formal bids.

There is a question in the minds of some engineers as to the advisability of reducing moment factors as suggested by the Bureau of Standards *Report No. 220*, but as the United States Bureau of Standards considers this type of floor construction safe and as we know structural formulae are theories proven empirically, there is no reason to doubt the safety of such floors. Economy is good engineering. The history of flat slab design offers a precedent. As the system lends itself to light loads and panel dimension of school construction, the girders along peripheries give a better distribution of loads to columns than the one-way systems, thus reducing the unbalanced moments transmitted thereto. The tie-through gives structural unity. The saving of plaster and simplicity of forms appeals to the contractor.

The intermediate column added along the corridor side of classrooms in design No. 3 is governed in minimum diameter by the height rather than economic design as in design No. 2. Column forms cost more per square foot than beam forms. This, together with the saving of floor space by omitting the intermediate column, effects an additional economy of approximately $1,200 by using design No. 2.

Most of the masonry contractors have enthusiastically approved of design No. 2 because it is possible to complete the concreting operation before bricklayers are needed on the job. In the past it has been a piecemeal proposition involving laying off and re-employing men. It is also less expensive to lay up a 4-in. brick veneer with 6-in. hollow tile backing than a 12-in. solid brick wall. The heat loss through the former is less.

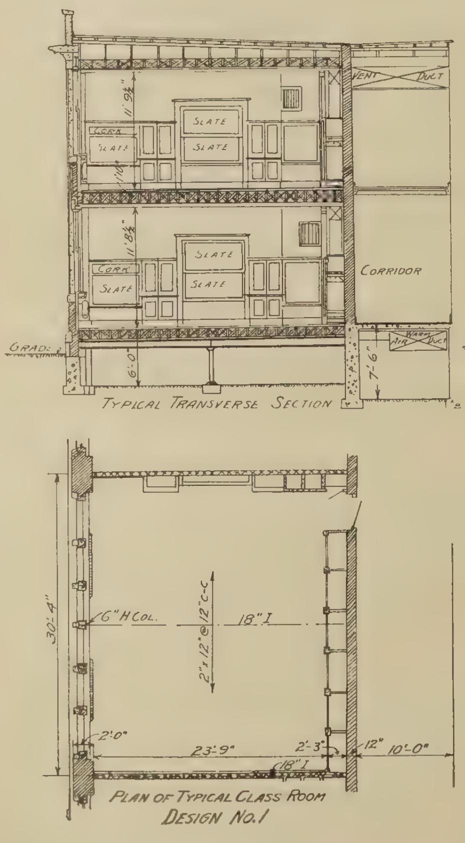
The first floor system of design No. 3, as indicated in the section following, being laid directly on the ground, is not good construction. Experience has taught us that it is not only cold and damp underfoot but unsanitary. No precaution of preparation of foundation and waterproofing of strata will give to subsoil a uniform settlement. Cracking is bound to result and rotting of wood sleepers and flooring, or linoleum as the case may be, will cause a higher maintenance cost. Placing the floor on the ground required that space for piping be furnished above the second story ceiling, which ceiling had to be designed to carry a live load for the repairing of pipes. Metal venitlation ducts in the excavated basement of design No. 2 had to be replaced by concrete plenum chambers in design No. 3. In the latter, cross branches and conduits required concrete trenches under the first floor slab. The attic of design No. 3 naturally involves a higher building and more exposed wall area.

It should be noted that design No. 3 calls for a reduction in the width of classrooms from 23 ft. 9 in., Rochester's standard, to 22 ft. 0 in. Wardrobes are within the rooms along the corridor side. *The Candle of Efficiency* as published by the Committee on Standardization of School Buildings of the National Education Association was applied to designs Nos. 1, 2, and 3. The following table shows the division of floor areas in percentages according to the above named standard:

	Without Addition	With Addition		N.E.A.
	Design No. 1	Design No. 2	Design No. 3	Average
Walls and Partitions	7.10%	6.80%	6.94%	10.00%
Flues	1.80%	1.75%	1.54%	3.00%
Corridors and Stairs	22.70%	20.15%	22.02%	20.00%
Accessories	.00%	.00%	.00%	1.00%
Instruction	54.70%	59.00%	55.00%	50.00%
Administration	13.70%	12.30%	14.50%	16.00%
	100.00%	100.00%	100.00%	100.00%

Much could be said about maintenance and more thought should be given to it. Design No. 1 is not the structural unit that design No. 2 is, so naturally more unequal settlements and cracking of plaster, brickwork, terrazzo, and tile work can be expected. Design No. 3, with its first floor on the ground and its exterior bearing walls lacking the tie-through of design No. 2, will have unequal settlements. The fire hazard in design No. 1 is much greater than in designs Nos. 2 and 3. The spending of an additional $2,500 to complete the sprinkler system in design No. 1 would further reduce the difference in cost between design No. 1 and design No. 2.

The figures received indicated that 85% ($58,100) of



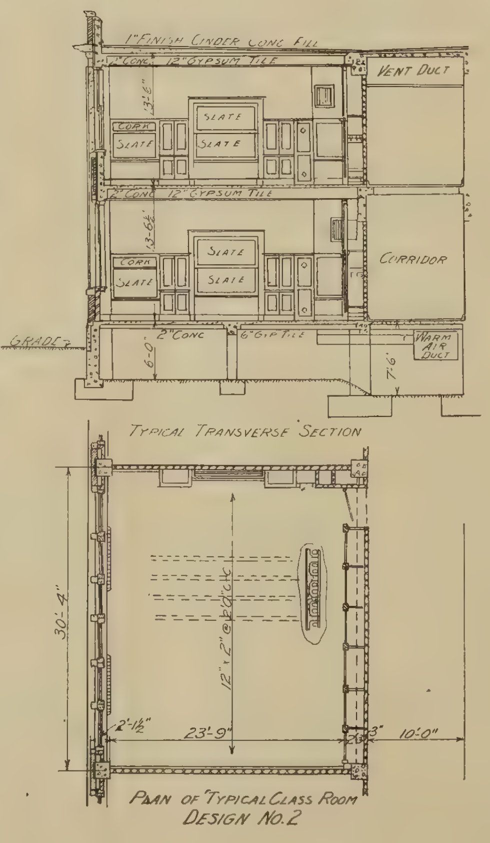


Fig. 1—Design No. 1—Wood Joists and Floors

Fig. 2—Design No. 2—Reinforced Concrete Skeleton Supporting Walls and Floors

the economy of design No. 2 over design No. 3 was in the mason work. The heating, electrical and plumbing figures showed an economy for design No. 2 over design No. 3 of approximately 3% ($2,000), plus the cost of ventilating ducts of design No. 2. This was largely due to the fact that the exposed wall area of design No. 2 is 8,300 sq. ft. less than design No. 3. The saving is slightly offset by the better facilities for piping and conduit work in the attic of design No. 3.

Separate bids were received for each branch of the work, contractors for each branch having equal rights on the premises. The foregoing summations are the totals of low bids on all individual classes of work.

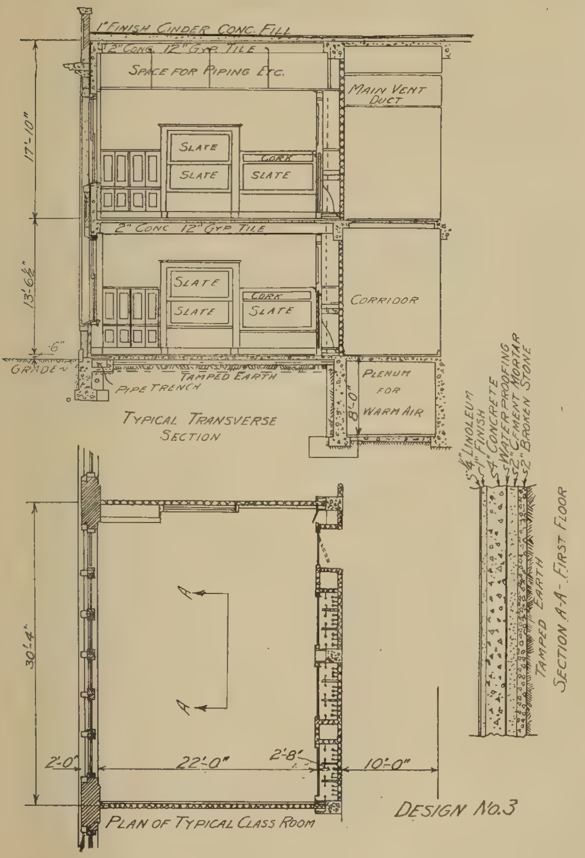


Fig. 3—Design No. 3—Brick Bearing Exterior Walls with Reinforced Concrete Skeleton Supporting Main Part of Interior

Many alternate figures were received. Under design No. 1 for the fireproofing of steel beams and columns above basement, as required by the city code, a bid of $6,000 additional was received. If cinder brick be used for facing exterior walls, there would be a saving of $2,100. Under design No. 2 wood floors on wood sleepers in cinder concrete fill in classrooms would cost $2,314 more than linoleum as specified. It has been estimated that if two-way floors were used a saving of $10,000 on this design could be effected, not taking advantage of the decreased floor thicknesses but leaving floor elevations as indicated. Under design No. 3 cinder brick would save $3,592, two-way tile floors would cost $2,835 more than gypsum one-way tile floors, and cross-ribbed tin pans would save $7,147.

Although it is not prudent to draw definite conclusions from isolated cases, the economy of a reinforced concrete skeleton for school buildings is so positive that it should appeal to the structural engineer and more vitally to the owners, the taxpayers.

Smaller Payrolls—Bigger Profits

By Thomas W. Noble

(In *Wisconsin Concrete Products Digest*)

The concrete block manufacturer finds that several of the items making up his costs are fixed by outside agencies. He cannot control the cost of cement or aggregate. His rental, taxes, depreciation of buildings and many other of his overhead charges cannot be reduced.

However, the largest single factor in the cost of concrete products is extremely flexible, and can nearly always be lowered by a careful study of his manufacturing methods.

Labor enters into the cost of a concrete block at every step in its manufacture from the reception of the aggregate to placing the finished block on a delivery truck. Far more labor is spent in handling raw materials and finished products than in actual manufacturing processes. To increase profits in a concrete block plant, the labor cost of each operation from delivering raw materials to unloading finished products must be reduced. To conclude that the installation of a power tamper *alone* solves the labor problem is as unintelligent as it would be for a farmer to cut his grain with a modern binder and thresh it with a flail on his barn floor.

The slow expensive method of shoveling concrete aggregates into a wheelbarrow and wheeling them to the mixer should be replaced by mechanical devices such as a track hopper with bucket elevator to place the aggregate in a bin over the mixer. Aggregates should descend by gravity into measuring hoppers if a batch mixer is used, or directly into the aggregate hopper of a continuous mixer.

Mixed concrete should be mechanically elevated to the feeding hopper of the block machine and automatically fed into the mold box. The slow, back-breaking, disagreeable work of shoveling materials off the floor should be eliminated.

Finished block should not be carried from the machine, but should be placed on racks within easy reach of the operator. Either cars and track or a special rubber-tired lift truck with spring frame may be used to convey block to the curing rooms. A most satisfactory method of transporting cured block to the storage yard is furnished by a gravity roller conveyor.

Material handling equipment such as outlined above lowers labor costs. With it the manufacturer is able to speed up the various operations in his plant so as to obtain maximum production from his block machine. It is poor economy to have a machine capable of producing 1000 block per day, limited to a production of 500 by an inefficient method of off-bearing the finished block.

It costs money to install labor-saving equipment, but it costs more not to do so. Wherever production is carried on in a haphazard, wasteful, inefficient manner, the unnecessary labor paid for in a single season represents many times the cost of efficient equipment. The manufacturer pays for modern machinery whether he installs it or not. He pays for it in pay rolls unnecessarily high. He pays for it in discontented workmen, inferior products, and inability to promptly fill his orders. Machinery that speeds production, lowers labor costs and improves the quality of the product is real investment.

Improving and Expanding the Concrete Block Business

What the Manufacturer Can Do

For several years unparalleled activity in building construction has prevailed. Demand for building materials has been so heavy that the problem of the producer of these materials has been to fill orders rather than sell his products. There is every indication that the building boom will continue next season. Slack periods, however, are sure to come. Competition of various types of building units will then be acute. Public preference will have a decided effect upon the building units chosen. Salesmanship will be a big factor in the success of building material enterprises.

In a severe competitive field, will the concrete block industry continue healthy? The merits of concrete block are unassailable. They are permanent, economical and adaptable to many different uses. But people do not know these things. They judge the present from the past. They often think of the block manufacturing as it was once: "The crimes of the '90's." Many still consider concrete block worthy of use in foundations, factory side walls or sheds, but not suitable for first class masonry. In this number are still no small company of architects, contractors and builders.

Although the concrete block business has blossomed beautifully during the last three years, there is still an immense sales resistance which the manufacturer can overcome. Millions of dollars are invested, and thousands of men are employed in the industry, yet few industries of this magnitude, if any, are doing less to promote the use of their products.

The concrete block industry is decentralized. There are many small plants. Thus the publicity given to this building unit is governed by the attitude of the owners of each plant. If every owner enthusiastically contributed his mite, the total amount of publicity would be enormous. Every owner should so arrange his business that a definite amount of time can be devoted to sales and promotional work. All of the larger plants should maintain salesmen, capable of selling concrete block during slack periods and of promoting future orders when demands are taking capacity output. Now is the time for the concrete block manufacturer to resolve that his product will be universally recognized as one of the best masonry building units and actually begin systematically to promote his business. The few manufacturers who are active in publicity work cannot, and should not, carry the load for all the rest.

Local Campaign Outlined

The promotion of concrete block can readily be separated into two general divisions: First, convincing individuals who have particular interests in building construction; second, creating favorable sentiment toward the use of concrete block by the general public. Individuals are best reached through direct personal contact, and the public mostly through indirect means. People who have direct contact with building construction are divided into groups, each of which can be approached by showing that the use of concrete block will directly benefit them.

Building Officials

Concrete block manufacturers should gain and keep the good will of building officials. If there is no ordinance regulating the quality of concrete block, the manufacturer should see that such an ordinance is adopted requiring a standard quality of product. Practically all of the larger cities have enacted concrete block ordinances. The standards of the American Concrete Institute provide a good place to start from. The Portland Cement Association regularly gives assistance in such matters.

The value of an ordinance cannot be over estimated. Primarily it gives official recognition to concrete block as one of the standard building units. It controls quality upon which the ultimate success of the concrete block industry depends. It works no hardship upon any manufacturer, because all are subject to the same regulations. It prevents unreliable block manufacturers from meeting the competition of responsible manufacturers by underselling them with inferior products. The prospective builder can select concrete block with reasonable surety that he can depend upon their satisfactory performance in service. Copies of tests that an ordinance should require will prove of great assistance as a selling argument. Good tests also secure the good will of public officials, whose approval is necessary upon building construction.

The advantages to the industry of a good ordinance, rigidly enforced, are so great that the manufacturer should insist upon the ordinance and personally make sure of its enforcement.

Bankers

As a business friend, the banker can assist the concrete block manufacturer in many ways. The fact that block are consumed locally, that local labor is employed and that local materials to a great extent are consumed, will enlist his cooperation. He should be induced to visit the block plant and observe the processes of manufacture. He should be given the opportunity to review the books of the plant, which always should be in good order. He should be convinced of the stability of the business and informed of any plans for contemplated enlargement of manufacturing facilities. When once thoroughly persuaded that a certain concrete block company is worthy of support, the banker will always be ready to loan money to carry accounts outstanding, for building up a large stock in winter in preparation for early spring deliveries, and for necessary additions to plant and equipment.

The banker bears an important influence upon the business transactions in his community. He is the confidant and advisor of his clients. As such, he can help the concrete block manufacturer materially, if he knows the merits of concrete block as a building unit. He should have in his possession copies of any tests made upon the local factory's block. He should be given the same data as given realtors, which will be discussed later. He should be made familiar with all good concrete block buildings in the neighborhood and be taken to investigate them personally. As a believer in concrete block, he can advocate the use of concrete block in buildings to be built for his patrons, and will make generous loans for the construction of concrete block buildings. A casual remark by a banker friend, "Why don't you use Jim Jones' block?" will carry a lot of weight.

REALTORS

Personal attention can profitably be given by the manufacturer to realtors and speculative builders. Their principal concern is profits, and they should be shown that good prices can be obtained for concrete masonry houses. They must be well informed as to the special advantages of concrete block construction, so that they may use the merits of such construction as selling arguments. The main points to be covered follow: Concrete block construction is permanent. The strength of concrete units increases rather than decreases with age. Because of their permanency, concrete block structures do not deteriorate and have little depreciation. Concrete block buildings can be made very attractive by the use of exposed aggregate facings or plain block covered with portland cement stucco. As a base for stucco, concrete block excel. Stucco becomes an integral part of the wall, due to the suction of the block which firmly imbeds tiny mortar teeth from the stucco surface. Concrete surfaces have a texture and beauty all their own. Concrete block cannot burn, and the liability of fire loss is greatly reduced. A concrete house, with a roof covered by concrete roofing tile or asbestos-cement shingles, is practically immune from fire originating from outside sources. Concrete masonry does not require painting. Concrete block buildings, furred and lathed upon the inside, require a minimum amount of fuel to heat. Armed with such selling arguments as these, the realtor can obtain handsome returns from the possible slight additional investment needed for block construction. The concrete block manufacturer has no reason to be discouraged if his first visits to realtors bring no results. Long-continued practices are not changed overnight. Progress, however, is inevitable and the concrete masonry house is a distinct advance in building construction.

MASONS AND PLASTERERS

How many concrete block manufacturers have enlisted the support of masons and plasterers? A large number of these craftsmen can be reached by addressing the regular meetings of their respective organizations. The masons would be interested in a discussion of the details of concrete masonry construction. A good deal of information for such a talk can be found in the booklet, "A Manual of Concrete Masonry Construction," published by The Portland Cement Association. Good block are sometimes misused in construction. Faulty workmanship has sometimes spoiled otherwise good construction. It is to the advantage of the manufacturer to encourage the proper use of his material. Masons should be strongly impressed that their work should not be confined to basements, but should extend to the roof. Concrete masonry construction will accomplish this result.

Concrete block with portland cement stucco is rapidly gaining in favor for above-ground masonry construction. This type of masonry adapts itself readily to good architectural treatment. The stucco surface can be made attractive by many distinctive treatments. These facts can be enlarged upon in addressing meetings of plasterers' organizations. Special emphasis can be given the fact that each home built in this manner means a job for the plasterer. It is to the advantage of both the block manufacturer and the plasterer that good quality portland cement stucco predominate in their locality. Sales of future block and stucco construction depend upon the condition of old stucco surfaces.

Again the Standards of the American Concrete Institute should govern. The Portland Cement Association has a booklet, "Portland Cement Stucco," based mainly on the "Standard Recommended Practice for Portland Cement Stucco" of the Institute, which gives a concise account of the principles of good stucco. Good use of this booklet can be made at a plasterer's meeting.

ARCHITECTS

For the development of the use of concrete building units in the best type of buildings, the industry is bound to rely upon the architect. Very few block manufacturers have a true appreciation of the value of well-proportioned form or artistic combinations of color. The novice who persists in trying to design good looking buildings without a capable architect does the material he uses a great deal of harm. The finest, most tasteful and pleasing homes are those designed by the architect. Such homes, if built of block, help to sell more block to discriminating buyers, while ugly, badly proportioned houses drive business away. For small homes, advantage can be taken of any one of several collections of architectural plans done by capable architects. A book of house plans by the Portland Cement Association was especially prepared for the use of block. If concrete units are to be used in expensive houses, the architect specializing in residential design must be acquainted with the adaptability of these units to artistic treatment.

It is a mistake to try to overcome any deep-seated opposition that the residential architect has against the appearance of rock face concrete block structures. In general, rock face concrete block is unquestionably an ugly looking unit. It is for the manufacturer to conform with the architect's requirements rather than attempt to advise him in his own special field. The use of portland cement stucco as a means of expressing architectural values should be suggested, and the advantages of concrete block as a base for stucco definitely shown. Pictures of attractive concrete block and stucco homes designed by other architects will greatly assist.

The architect will be interested in the strength and absorption of concrete block made locally. Authoritative tests will again prove valuable. If possible, a visit to the plant should be arranged for. Details of correct concrete masonry practice will clear up objections as to construction difficulties. There are not many residential architects in each locality, and all of the best residences should not be built of other materials because the architects have had no opportunity of learning of the structural value, economic advantages and adaptability of concrete block.

CONTRACTORS

A large portion of the concrete block output is sold directly to the small contractor, who is often in daily contact with the products plant. Many solid friendships have been formed by this contact between the manufacturer and the contractor. Yet the house builder is seldom an advocate of concrete block for above-ground construction. A majority of small homes are designed by the builder. Often the small contractor began his career as a carpenter, and is partial to frame construction both because of his knowledge of such construction and because of loyalty to his old trade. These obstacles will usually disappear after the contractor has built a single concrete block house and has made a fair profit upon it. It would seem that some of the best opportunities for the concrete block producer to assure and increase his future business are being overlooked because they are so close.

As in the case of the realtor, the first consideration of the contractor is in profits. He needs, then, the selling information given the realtor, and, in addition, detailed instruction in correct and economical methods of concrete masonry erection. It should be very easy for the contractor to estimate the costs of concrete block walls, for above-ground construction is the same as foundation work, with the addition of stucco on the exterior and the setting of furring strips inside. Cost of extra labor at openings can be compared with that of setting the basement windows, and prices of precast sills and lintels can be furnished by the products manufacturer. Mason contractors will be glad to figure the walls complete if the general contractor does not wish to look after their construction himself. Although contractors will build with any materials the architect or owner insists upon, he can often exert an important influence toward the more generous use of concrete products if he is, himself, convinced of their merits and conversant with their economies.

General Publicity Needed

Thus far, means of convincing men who have a direct interest in building construction of the worth of concrete block construction has been dealt with. It is of equal importance to secure public esteem. Long existing prejudices must be overthrown. The manufacturer should collect facts to combat each objection, and then take all possible means to educate the public upon the merits of concrete block construction, at the same time answering commonly expressed complaints.

Objections and Their Answers

Quality is the foundation upon which the future business of any concrete block manufacturer is laid. Poor block will not last, good block are permanent. Reports of periodic tests will give confidence to the user. Should a large or important prospect for the use of concrete block arise, the manufacturer should always be ready to suggest that any block be selected from his stock pile for test. Many people pass concrete block plants daily, and their opinion of the block itself will be favorably inclined by the sight of a well-arranged factory, neat stock piles and well-kept yards *free from broken pieces of concrete block.*

It is a common belief that concrete block structures are damp inside. There are two reasons for this conviction: (1) rain may possibly penetrate weak, porous block or bad joints, and (2) condensation of interior moisture may appear on the inside surface of any type of masonry walls in cold weather when no provision is made to prevent it. Cases of actual water penetration are rare, and can be traced to a very inferior product or to joints which are not filled with mortar. Well-filled joints are necessary in basements where the natural soil is damp or wet. Absorption tests, which are very easy to make, will demonstrate that concrete block of quality required by a standard ordinance will have no more, and usually less, absorption than common brick. In cold climates it is recommended that the interior of masonry walls be furred and lathed. This effectually prevents condensation upon the inside of the walls, as the plaster is separated from the wall by an air space and therefore is quickly heated to the temperature of the room. This condensation on unfurred masonry walls has nothing whatever to do with waterproofing problems. The moisture that collects on the outside of an ice pitcher in a warm room does not come *through* the pitcher. It comes out of warm air in contact with a cold surface. The worst feature of an improperly built masonry wall is not the moisture of condensation, but the fact that this condensation is an indication of heat loss and waste of fuel. The manufacturer should look up all homes or offices built of concrete block, and obtain statements from occupants to the effect that it is their experience that concrete block buildings are not damp. He should also see to it that new concrete block buildings are well constructed.

Numerous old concrete block buildings are ugly. The average man judges the appearance of concrete block buildings by these examples. He has not learned that attractive concrete block structures can be built. The concrete block base cannot be seen on attractive stucco homes. Concrete block with surfaces imitating other materials are an abomination. The concrete block manufacturer should stop making them as soon as possible. Customers who ask for them can often be persuaded to buy plain faced block. Exposed top basement courses of well-made plain-faced block are much more pleasing than those made of monotonous imitation rock-faced surfaces. Where block exteriors are used upon high-class construction, exposed special aggregate surfaces are preferable. For precast sills, lintels, trim stone, porch columns or chimney block, many acceptable varieties of surface can be made, using white cement or exposed colored aggregate. Special colored aggregate is readily obtained.

Advertising

The manufacturer can easily collect material which will answer every objection to concrete block. The problem is to get this material before the general public. Comparatively few people can be reached personally, and therefore indirect methods are to be employed. There are many effective methods for publicity. By continued persistent effort, the block manufacturer can make his product a household word, and eventually cause it to be recognized as a reliable standard building material for the most pretentious buildings.

Sign-boards

A distinct advance in promoting concrete block has been made when the public is familiar with the simple words "Concrete Block." A generous use of signboards is inexpensive. A large plain sign on the products plant will inform every passer-by that concrete block are made there. A smaller sign can be placed in a prominent position, with an invitation to step inside and see block made. People like to see machinery go. Even if it is curiosity alone which prompts the visitor to enter, good publicity has been gained. Every truck belonging to the products man should have neat legible advertising signs. When contractors' or jobbers' trucks are to deliver several loads of block to the building site, detachable signs can be used on the truck. A small sign should be placed on every job where block are being used. It is not necessary to collect such signs as soon as the block have been laid. They will always work until they are needed upon another job or until it is convenient to pick them up. The products manufacturer can make free use of signs at comparatively small cost.

BOOKLETS AND LEAFLETS

Every block manufacturer should have a carefully prepared booklet or leaflet. It should contain simple, direct reasons for the use of concrete block. Advertising matter upon cheap paper with inferior printing is useless. Cuts showing attractive concrete block buildings arrest favorable attention. People like to look at pictures. The text should not be lengthy, or it will not be read. Paragraphs and sentences should be short. Great care should be exercised that incorrect or indefinite statements are not made. Extravagant claims or high-sounding phrases are not effective. Sound common sense and plain wording carry weight. A carefully planned initial distribution is advisable, reaching the classes of men noted in preceding paragraphs. Literature should be carefully distributed to those most likely to read it.

NEWSPAPER ADVERTISING

Newspaper advertising can be employed with telling effect. A progressive newspaper campaign generally produces better results than one or two large advertisements. When newspaper men know the importance of and interest in a product, they are likely to publish stories of news interest about it, dealing with new buildings made of concrete block, a description of the local plant, results of fire tests, etc. Business and industrial news gets a good deal of attention in newspapers these days. But be sure to put the matter up to the newspaper man on a *news* basis. If he is an honest newspaper man he will "see red" about the time you ask him to run a "write up" just because you are buying advertising space. Nobody but a journalistic prostitute will give you editorial or news space in return for advertising patronage. In large cities newspaper advertising is expensive, and where one product manufacturer cannot afford a regular campaign, several can undertake it jointly. A few words in bold type is preferable to long statements in smaller type. Cuts for concrete block advertisements, prepared by experienced publicity men, may be obtained from the Portland Cement Association at cost. The good results of newspaper advertising may not be readily apparent, because many inquiries will be received which cannot be traced to their original source. Newspaper advertising is, however, a very direct means for reaching a great number of people. The concrete block idea once firmly established in public opinion, assures a steady increase in demand.

INFORMATION FILES

During the discussion, it has been suggested that the block manufacturer collect information to be used for special purposes in the sales and promotion of his product. A place should be provided where all data favorable to concrete block or to any of its uses can be filed. Photographs, booklets, clippings, testimonial letters, copies of tests, etc., make valuable sales ammunition. Frequently printed statements will be believed where the same facts spoken verbally are not effective. If the products man is ever asked a question which he has not been able to answer satisfactorily, he should immediately get data to answer similar questions in the future and place it in his permanent file.

ASSOCIATION MEMBERSHIP

The concrete block manufacturer should take an active interest in the civic affairs of his community. He should be a member of the local chamber of commerce or other business organizations and attend their meetings. In the larger cities, he should belong to the concrete products association. If there is no such association, he should organize one, which can do many things beneficial to the industry that the individual would not attempt.

The more intelligent and progressive concrete products manufacturers will recognize also the value of membership in the American Concrete Institute, because here he will participate in raising the standards of his business, and he will enjoy the advantage of cooperation of men of broad training in concrete.

It is not advisable to go after competitor's customers; this will not increase the block business. Time spent in selling new customers for concrete block is well spent; this increases the block business. Old customers can be kept by service and quality goods. Confidence in a block manufacturer will grow if he does not discredit his competitor. If the competitor's block are inferior or his business methods unfair, these facts will soon become known. Cooperation among manufacturers will tend to solidify and strengthen the industry. The manufacturer should teach all his men the qualities, merits and uses of concrete block. If this practice were general, thousands of employees would become more interested in concrete block, and would be added to its open advocates. Square practice, reliability, industry and good fellowship are good business.

The concrete block is an economical and satisfactory building unit. The growth of the industry will be remarkable, if concrete block manufacturers will determine to do just two things: namely, produce quality products, and then market them efficiently. Chase & Sanborn's coffee, Gillett razors, Ivory Soap and Wrigley's gum are all good products. Many other good coffees, razors, soaps and gums are made. The immense distribution of these special brands is due, however, primarily to the sales and promotional campaigns placed behind them. The individual concrete block manufacturer cannot put over a campaign comparable to that of the large companies noted. If each of the seven thousand concrete block manufacturers will only do his share, there is no reason whatsoever why the results will not be the same. May each concrete block manufacturer forget petty personal differences; never confuse the public by belittling competitors' block because of its shape, size or finish, but use all his energy to put across the one big idea *Concrete Block*. There is one thing more. It is a practice which will win confidence. Never over-promote your products. Do not advocate them for use where something else is undeniably better for the purpose. Remember in promoting concrete that concrete enthusiasts are often "nuts." Leather is better for shoes, and custard for pies. Be generous toward other materials. Wood for some purposes is better than concrete.

Soap Instead of Oil for Forms

Although no specific tests have been reported recently to show that crude oil prevents bonding of concrete, it is generally recognized that it is impossible to get rid of the thin oily coating after oil has been used on forms in concrete construction work. Anything which cuts down the suction between coats, leads to weak bonding.

It has been suggested that soap would avoid this condition and a cheap soap thoroughly dissolved in water to a consistency of a very thin paste and applied hot with a whitewash brush or broom would undoubtedly give as good results as oil where it is desired to apply a finishing coat to the surface of the concrete after the removal of the forms. As the soap is soluble in cold water, after the forms are removed, the concrete could be hosed down and would have a better surface for the bonding of plaster.

Disintegration of Cement in Sea Water

Brief reference was made in our July issue to a paper by William G. Atwood and A. A. Johnson before the American Society of Civil Engineers in June, on "The Disintegration of Cement in Sea Water." The paper summarized the research findings on this subject, and, as one says in the discussion which has followed, "condenses admirably the work that has been done and forms a permanent, easily accessible record of that work." Not only that, but it has supplied the basis for considerable interesting discussion from several different viewpoints.

B. Jeanneret, engineer-chemist, Liege, Belgium, discusses permeability with various binders, among them portland cement and *ciment fondu.*

E. G. Walker, Westminster, London, discusses the wisdom of approaching the sea water problem with the idea that, as in the development of iron, with various alloys to meet special purposes, "different purposes can be served best by different kinds of cement."

Interesting discussions by Albert Moyer and J. Y. Jewett are also published.

These two mentioned and several other discussions follow:

Permeability of Cements

By B. Jeanneret[1]
Ingenieur-Chimiste. Liege. Belgium

Additional information on the tests of *ciment fondu* will be found in the following discussion: The original chemical composition of cements is no guaranty of their value. It is the chemical combination which takes place in the moist mortar which is the principal factor in their ability to oppose the destructive action of sea water.

The combined silicates and not the mixtures of silicates produced after burning, are the agents which furnish the cohesive strength. It is for this reason that pure cements (portland, natural cements, well-burned hydraulic lime) offer a much better guaranty of the value of a mortar than the mixed cements (mixed cements or insufficiently burned lime rich in free lime). The value of adding trass, volcanic ash, etc., lies in the chemical reaction which they are able to cause.

The more prompt the chemical reaction of the silicates to hydration, the more readily the gelatinization takes place and the consequent impermeability of the mortar.

Porosity is the second important factor governing the value of mortars and concrete in water, that is, the physical resistance opposed to the penetration of water and, consequently, to the transmission through the pores of a saturated solution composed of the soluble salts of the mortar cement. This second kind of impermeability can be obtained by the selection of sands, fine pulverization, etc. The work of the engineers has considerably bettered these physical values of mortar and concrete.

The writer has made some tests of the impermeability of cements and other hydraulic binding agents, following the methods indicated by Le Chatelier, and the results are given in Tables 3 and 4.

The impermeability may be tested by the penetration of test samples by a solution giving colored reactions. The limit of the coloration, which can be easily determined, gives an indication of the porosity of the mortar or cement. Tests were made on samples having the form of a figure "8" and on cylinders 30 mm. in diameter.

As reagents, Le Chatelier suggests alkaline sulfurs which produce a black coloration and are without any chemical influence on the cement. Better results were obtained by using a 10% solution of calcium ferrocyanide ($K^4Fe(CN)^6$).

TABLE 3—ANALYSIS AND COMPRESSIVE STRENGTH OF THE CEMENTS USED AND TENSILE STRENGTH OF 1:3 RAMMED MORTAR IN TEST D

Kind of cement	Analysis of Cement						Compressive strength of neat cement, in kilogrammes per square centimeter	Tensile strength of 1:3 rammed mortar, in kilogrammes per square centimeter
	SiO_2	Al.	Fe.	CaO	Mg.	SO_3		
1 Portland.......	21	7	3	62	1.7	1.3	350	32.5
2 Natural.........	19	8	4	56	2.0	1.6	270	25.7
3 Hydraulic lime..	18	7	4	55	1.7	1.8	200	18.4
4 Hydr. lime, inferior quality....	16	3	2	59	2.0	2.5	150	....
5 *Ciment fondu*....	15	40	10	32	1.0	1.1	800	62.0
6 Lime...........	13	3	2	59	2.0	1.9	135	....

All these tests give the strength at 28 days, and are made after the Swiss standard with 1:3 mortar and calibrated standard sand.

TABLE 4—PERMEABILITY OF CEMENTS

No.	Experiment	Kind of cement	Permeability, in millimeters
A	30-mm.cylinders of neat cement. Remained 3 months in the open air after fabrication. Plastic paste after Vicat's test.	1 Portland...........	1
		2 Natural............	1–2
		3 Hydraulic lime......	7–8
		4 Hydr. lime of inferior quality............	8–13
		5 *Ciment fondu*........	None
		6 Lime...............	12–15
B*	Moratar 1:3, plastic; moulds filled by hand without compression; river sand, screened; passed 335-mesh sieve, No. 50; retained on 484-mesh sieve No. 60. Tested 28 days after fabrication. (*a*)Hardened in moist air.	1 Portland...........	1–2
		2 Natural............	1–3
		3 Hydraulic lime......	4–5
		4 Hydr. lime, inferior quality............	7–8
		5 *Ciment fondu*........	0.5
		6 Lime...............	10–15†
B	(*b*)The same mortar, remained in water after setting. Tested 28 days after fabrication.	1 Portland...........	1
		2 Natural............	1–2
		3 Hydraulic lime......	4–5
		5 *Ciment fondu*........	None‡
C	Rammed mortar, 1:3 for standard test. Test of half-samples of 8 form. Remained 1 year in the open air after the tensile test.	1 Portland...........	2–3
		2 Natural............	2–3
		3 Hydraulic lime......	6–7
		6 Lime...............	10–11
		5 *Ciment fondu*........	2–3§
D	Rammed mortar, 1:3 for standard test Tested 28 days after fabrication. Test samples removed from water.	1 Portland...........	3–4
		2 Natural............	3–4
		3 Hydraulic lime......	5–7
		5 *Ciment fondu*........	0.5–2‖

*The samples remained in the coloring solution from 24 to 48 hours.

†Complete penetration in cylinders.

‡No penetration.

§Electric or Alca cement at the age of 3 months.

‖The dark coloring of the cast cement makes it difficult to observe exactly the depth of penetration of the red color.

In order to show the impermeability, the specimens must be immersed for a certain time in the solution mentioned. After cleansing with water, the samples are broken and colored by a cupric sulfate solution ($CuSO^4$). This produces a red coloration of the salts which have formed in the pores of the specimens. This coloration persists for a long time, thus making easy the observation of the limit of penetration and comparison with other specimens. From these tests it seems to be certain that the resistance of the hydraulic binding agents to permeability is not directly proportional to their tensile and compressive strengths, and that the chemical constitution of the silicates has an important bearing on the impermeability of mortar.

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[1] Copyrighted Proceedings A. S. C. E., Oct. 1923. P. 1762

Different Cements for Different Uses

By E. G. Walker[2]
M. Am. Soc. C. E., Westminster, London.

This paper forms an admirable summary of the major researches conducted during and since the Nineteenth Century, to establish the fundamental chemical facts which govern the setting of cement in sea water. Although the paper contains little that is new, it condenses admirably the work that has been done, and forms a permanent, easily accessible record of that work.

The author's complaint about the lack of basic experimental evidence on the subject in American technical literature is probably due to the fact that the attention of engineers has been directed largely to the problem of making a concrete that will withstand the action of sea water. The problem presented in the paper forms one (probably the most important) part of this general question, but it is likely to be overlooked in discussion and to be excluded by considerations relating to concrete manufacture, in which it plays no direct part Realizing the existence of the single standard type of cement, easily obtained, practical engineers have taken this element of the problem as a fixed quantity, and in their experiments have endeavored to obtain improved results from a study of the multitude of other variables which enter into the whole operation of making, placing, and hardening of concrete.

For timber construction, engineers select from the many different kinds of trees that most suitable by reason of its physical properties, cost, and durability, and the ease with which it can be obtained. Nature, in this case, has offered man a great variety of materials with which to satisfy his wants. With products requiring elaborate treatment in their manufacture, such as metals, engineers have been led by experience to develop various grades suitable for different requirements; for example, all kinds of ferrous products are used in structural work, from cast iron to special alloy steels, the compositions and treatments of which are designed to fulfill the requirements which arise in practice. The earlier engineers were restricted to the use of cast iron from which they constructed columns, arch ribs, and beams, their designs having been governed by the limitations of its strength and elasticity. Later, wrought iron was adapted to structural requirements, and methods of design underwent a revolutionary change on account of the introduction of riveted work and the development of the truss. From wrought iron, mild steel, and various forms of hard steel and alloy steel came into use, which, although not adaptable to all requirements, form the most efficient and economical materials for certain special uses. The writer sees an analogy between this and the probable future development in the use of cement.

The authors refer to the famous experiments of Smeaton, in 1756, to find the most suitable material with which to make the mortar for jointing the stones of the Eddystone Lighthouse. His experiments led him to use a material obtained by the burning of the blue Lias limestone, found at Aberthaw on the coast of Glamorganshire in South Wales (not in Devonshire, as stated by the authors), which he concluded to be the best hydraulic lime he could procure. The durability of the work proved the wisdom of his selection. The mixture of hydraulic lime and trass used by Smeaton was a cement in the broad sense of the word, but not in the special restricted sense of the present use of the term to indicate a product resulting from intimate mixing, fusion, and fine grinding of the constituents.

About seventy years after Smeaton's experiments, William Aspdin discovered the fundamental fact that by burning a mixture of chalk and clay a material could be obtained which had better hydraulic and cementing properties than the hydraulic limes used prior to that time, and which, as the authors show, had been investigated by Vicat, during and subsequent to 1812. Aspdin's discovery introduced to constructors a new material that differed fundamentally from the old, although in some respects it was in a similar category. During the last hundred years portland cement has been improved in nearly every way, and a much higher grade of material has been produced by better mixing, more complete burning, finer grinding, and improved methods of handling. Engineers have held, however, to the idea of producing one material for all purposes, yet Smeaton experimented, not because he was unable to find a standard material suitable for jointing stonework, but because he knew that the lime mortars then in use for building in the dry would not withstand the conditions found in sea works. Today, engineers modify cements in practice to a limited extent to suit special conditions. They make quick- or slow-setting cements by adding gypsum in various proportions during manufacture; and they know that different brands of portland cement have subtle differences of quality which cause one brand to be preferred for one class of work and another for another class, although both conform to the standard specification.

The successive developments of plain concrete, concrete blocks, reinforced concrete, concrete slabs and building tiles, and cement stucco, have introduced the use of cement in a variety of products second only to that of iron. It appears reasonable, therefore, that different purposes can be served best by different kinds of cement. The writer believes that this is a development which will come; the number of raw materials used in the manufacture of cement is increasing. There is already a cement made with blast-furnace slag, alumina cement, and others of different compositions. Unless these materials are to be developed as proprietary articles, it follows that eventually it will be necessary to formulate standard specifications for different kinds of cement as has been done for different classes of iron and steel. The British Engineering Standards Association has recently issued a standard specification for portland blast-furnace cement, which is defined as a cement produced by grinding together portland cement clinker and blast-furnace slag, the minimum proportion of the former being 35% and the maximum of the latter 65%.

* * *

Dense, Well Placed Concrete Not Decomposed

By Albert Moyer[3]
Affiliate, Am. Soc. C. E.
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New York City

This discussion is divided into a summary, an argument, and, finally, a statement of the problem to be investigated.

Summary.—The writer will attempt to show by this discussion that there is little foundation for the assumption that well-placed dense concrete, composed of the best portland cement and clean aggregate, is decomposed (chemically) by sea water either between tides or below low tide. The references mentioned by the authors seem to apply to investigations of the decomposition of concrete rather than to the disintegrating action. There is a vast difference between decomposition and disintegration; one is entirely chemical and the other is entirely mechanical, and, yet, in the Synopsis of the paper, the authors speak of "disintegration of concrete in sea water," failing to differentiate between the two actions. In the Introduction it is stated that "it appears to be reasonably certain that, if there is no chemical cause, serious failures of properly built structures need not be expected." The writer will attempt to show that disintegration (mechanical action) is the cause of a very large proportion of the deterioriation of concrete in sea water, whether the cement is high alumina, high silica, or whatever it is, as long as it is of good quality.

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[2] From copyrighted *Proceedings*, A. S. C. E. Nov. 1923, p. 1914

[3] Copyrighted *Proceedings* A. S. C. E., Nov. 1923, p. 1917.

In the following discussion a serious suggestion is offered that a thorough investigation be made of samples of concrete (both below tide and between tides) that have remained intact, and in satisfactory service for ten years or more. Having determined the cause of the success in these cases, engineers and others should formulate specifications and practical suggestions for the benefit of those who are about to undertake construction with concrete in sea water. The writer refers to concrete made of standard portland cement, sand, and gravel or crushed stone, without any admixture whatsoever, and, furthermore, concrete is considered as a rock, similar to that produced by Nature.

Argument.—A scientific problem is treated scientifically only if it leads toward a practical solution. The erosion, decomposition, and disintegration of rock (or concrete) is caused by various agencies. There are both chemical and mechanical methods of breaking up rocks into particles or of dissolving them. When rocks are broken up chemically, it is called "decomposition," and the product of decomposition differs from the original. The question arises, when concrete is eroded or disintegrated between tides, "Does the product of this destruction differ from the original material?" The mechanical method is merely a separation of the different minerals into their component parts, called "disintegration." When both decomposition and disintegration act simultaneously, under the influence of water vapor and gases, with accompanying temperature changes, the process is called "weathering." This latter action can hardly be the cause of deterioriation of concrete between tides, as the required water vapor and gases accompanied with high temperature are not present.

Artificial or natural rocks, as a whole, are poor conductors of heat, and, therefore, the surface layers are subjected to an expansive force, while the deeper layers are unaffected. It has been noted also that the wetting of concrete or natural rocks expands the surface and that drying contracts it. Therefore, between tides, the surface of the rock or concrete is always slightly in motion. This is one of the principal causes of hair cracks and "crazing" of concrete surfaces. The two actions, heat and water, might have some slight influence on the disintegration of the surface of concrete between tides. Various natural rocks and the aggregates composing concrete react differently to heat and cold, and, therefore, surface stresses in these rocks or aggregates are set up when temperature changes occur between tides, which might tend to separate one mineral from another. This is particularly noted in granite. The slopes of Pike's Peak, composed of coarse granite, are covered with such disintegration products. Finally, it is noted that minerals themselves are affected by these temperature changes, because minerals with several distinct crystal axes react differently on the various faces. Thus, a crystal of feldspar is itself subjected to internal stresses which open minute fractures along the cleavage line. This is how kaolin is formed.

Disintegration can be caused by the expanison of ice crystals. Water on freezing increases one-tenth in volume, and thus become a powerful agent in disrupting rock. Very rapid disintegration might occur to natural rocks if they were porous, or in concrete. If, however, the rock or the concrete were very dense and strong, it is not likely that frost action would have an opportunity to do its work of disintegration. The effect of frost on the soil is one of expansion, by filling the pores with ice crystals, which lift and separate the particles. This may be noted on a frosty morning. When the ice crystals have melted, the soil is left full of small cavities which give the mass a loose and spongy appearance much like that of porous concrete that has been similarly affected by the growth of ice crystals in the pores between tides. Similar action is occasioned by the growth of salt crystals. The following is quoted from the conclusions of the U. S. Bureau of Standards:

> Portland cement mortar, or concrete, if porous can be disintegrated by the mechanical forces exerted by the crystallization of almost any salt in its pores, if a sufficient amount of it is permitted to accumulate and a rapid formation of crystals is brought about by drying, and as larger crystals are formed there would be obtained the same results on a larger scale. Porous stone, brick, and other structural materials are disintegrated in the same manner.

The following quotation is from the Encyclopedia Britannica:

> Good hydraulic cements are highly permanent materials provided certain conditions be observed. It might be supposed that hydraulic cements from their nature would be indifferent to the action of water, but this is only true if the structures of which they form a part are sufficiently compact. In this case the action of water is checked by the film of carbonate of lime, which eventually forms on the surface of calcareous cement. This together with the compactness of the mortar, hinders the ingress and egress of water and prevents the dissolution and ultimate destruction of the cement. But where the concrete or mortar is not well made and is porous, the continual passage of water through it will gradually break up and dissolve away the calcareous constituents of the cement until its strength is utterly destroyed. This destructive action is increased if the water contains sulphates or magnesium salts, both of which act chemically on the calcareous constituents of the cement. As sea water contains both sulphates and magnesium salts it is especially necessary in concrete for harbor work to take every care to produce an impervious structure.

There is a preponderance of evidence that nearly all concrete that has deteriorated in sea water is situated between tides. The submerged concrete constantly under water is seldom affected by chemical or mechanical action of the sea water. It is, therefore, reasonable and logical to assume that disintegration is due almost entirely to the causes mentioned. Denser rock is affected much more slowly than porous rock, which accounts for the so-called "everlasting hills," composed of the densest rock, which was formed in pre-Cambrian times.

The Problem.—The writer believes that it is futile to carry on exhaustive research work in regard to the chemical cause of the decomposition of porous concrete, but that thorough investigation, based on existing successful structures which have been immersed in sea water or between tides for ten years or more, can lead to conclusions of the greatest value.

From the numerous examples of such construction, undoubtedly information may be obtained, giving the specifications, the kind of aggregates, the character of the portland cement, the proportion and, possibly, the methods of mixing and of placing. This will furnish the nucleus for research work, leading to proper recommendations. One of the best references on this subject is a report of a Special Committee, appointed by the Institution of Civil Engineers of Great Britain to study the deterioriation of timber, metal, and concrete, when exposed to the action of sea water. This report[4] was edited by Messrs. B. M. Crosthwaite and C. R. Redgrave, and is a compilation of reports of various members of the Institution on the condition of structures in all parts of the British Empire, written for the most part by members who are officially connected with the operations of the various ports. In general, their attitude toward concrete is very favorable, and they seem to have had almost uniformly successful results in some cases for more than 10 years. The first report was issued in 1920 and a second in the latter part of 1922, or the early part of 1923.

In the report of Committee E-6 of the American Concrete Institute presented to the Annual Meeting of the Institute at Cincinnati, Ohio, in January, 1923, there appears a table (Table 2) on the Aberthaw tests of concrete in sea water, carried on at the Charlestown Navy Yard, Boston, Mass. This table certainly bears out the writer's argument. The dense concrete stood up well regardless of the cement used.

In the investigation and research work which, it is hoped, will follow this discussion, it is respectfully suggested that in examining concrete that has decomposed (that is, where it is assumed that chemical action has taken place), the sediment which may remain in the pores be analyzed to determine whether or not it differs from the material of the original concrete. Unless it differs, it shows disintegration or mechanical action and not decomposition.

To repeat, the problem is to ascertain why the numerous and prominent examples of concrete have withstood all these alleged chemical and mechanical actions and are still performing their useful functions although immersed in sea water for periods of more than ten years.

* * *

Sand Cements

By J. Y. Jewett[5]
Assoc. M. Am. Soc. C. E.
Testing Engr., City of San Diego, San Diego, Calif.

The authors state[6] that they have been unable to find any record of tests in the United States on pozzuolanic materials with relation to resistance to the action of sulphate-bearing waters. Reference is made to the use of "blended" cements of this type, as represented by the sand cements used in certain dams built by the U. S. Reclamation Service, and the tufa cement used on the Los Angeles Acqueduct, and surprise is expressed that no sea-water or alkali-soil tests of these cements were made. Although no results were published, a set of such tests, under alkali-soil conditions, was made by the writer about ten years ago, during his period of services as Cement Expert in the U. S. Reclamation Service.

A review of the experience of the U. S. Reclamation Service in dealing with the problem of alkali action on concrete may be of interest. When this trouble first appeared on certain projects in 1908, it became evident that a study of the subject was needed. The officials of the Service felt that Reclamation funds could not be used for such purposes, and asked the Structural Materials Laboratory of the U. S. Geological Survey (later transferred to the U. S. Bureau of Standards) to consider the matter. This led to the inclusion of a study at Atlantic City, N. J., by this laboratory, of alkali action with one of sea water action, the results of which have been published.[7]

In the meantime, the writer made some field experiments with the limited facilities at his command and with such aid as could be obtained from the engineers of the projects affected. At first, these experiments were conducted on small specimens made in the laboratory and sent to the various projects for exposure where alkali action was most severe. Later, a series of tests was started on specimens made in the field, using, in part, materials sent out from the laboratory, and, in part, materials available on the projects themselves. The materials used included sand cements manufactured by the Service, and also a so-called "alkali-proof" cement of the same general type from one of the cement companies. In the latter cement, blast-furnace slag was the siliceous material used in the blending process. The series also included samples of various other materials and processes, for which claims of waterproofing properties had been made. The specimens were in the form of blocks, about 24 in. by 9 in. by 12 in., and, when exposed for test, were placed on end, about one-half being above ground line or water line.

Observations of the action of these specimens showed that a rich dense mixture of portland cement concrete was more resistant to the alkali action than that of any other material used. The writer felt, however, that the series was not sufficiently comprehensive to be conclusive, as it was difficult to get the attention to details so essential in carrying out the series as a whole. When the writer urged the need of coordination by the employment of an assistant whose duty would be that of conducting a field series on a broad scale, keeping detailed records of all factors having a bearing on the problem, he was again met with the limitation of lack of funds for work of this type.

Arrangements were made, however, with the U. S. Bureau of Standards to add to its work on drainage tile a series of tests on mass concrete. The results of both these series have been published in the *Technologic Bulletins* of that Bureau. The Committee which outlined the program for this series of tests confined them to straight portland cement concrete. As previously stated, the results obtained on the series carried out by the writer were not published, but they were available to this Committee, and may have influenced its decision to restrict its test to various proportions of mix and types of aggregates, using only portland cement concrete.

One point of importance in the use of these blended cements is that of their durability under general climatic conditions, aside from the special service conditions under discussion. Experience has shown that the sand cements of the Reclamation Service, while excellent for use in mass concrete in a large dam where not exposed to surface wear or weathering, are not as durable as portland cement where thus exposed. In this connection, it developed that laboratory tests did not fully indicate field service qualities. Materials showing high strength in laboratory tests developed poor wearing qualities and lack of resistance to frost action in the field. This was markedly true of the previously mentioned "alkali-proof" cement.

Granting the soundness of the theory on which is based the proposed use of cements of this type for resistance to sulphate-bearing waters, it would seem, therefore, that in the experiments recommended by the authors, one of the main features should be the selection for blending of those siliceous materials which will prove not only resistant to the action of these waters, but also to frost action and other climatic effects.

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[4] Published by the Committee at Great George Street, Westminster, S. W. 1, England.

[5] Copyrighted *Proceedings* A. S. C. E., Nov. 1923, p. 1920.

[6] *Proceedings*, Am. Soc. C. E., August, 1923, p. 1053.

[7] *Technologic Paper No. 12*, U. S. Bureau of Standards.

Incidentally, it is of interest to note that the term "sulphate-bearing waters" is coming into use in the discussion of the action of both sea water and alkali on concrete. It became evident in the early stages of the investigation of alkali action, that the sulphate salts were the principal cause of disintegration. Therefore, the term "sulphate-bearing" is more suitable technically than the general term "alkali," which has been so commonly used in this connection.

As a matter of correction, also, it may be noted that, although sand cement was used in the Arrowrock and Elephant Butte Dams of the Reclamation Service, it was not used in the Shoshone Dam, as stated by the authors. The Shoshone Dam was built at an earlier period than the other two dams, at a time when investigation on sand cement had not reached a stage where its use seemed justified.

Houston Concrete Sewers Investigated

An investigation of concrete sewers in Houston, Texas, is reported in two letters, one by G. L. Fugate, Principal Assistant City Engineer, ordering the investigation, and a reply by W. S. Stanley, Chemist, Sewage Disposal Plants. Here are the letters:

Mr. W. S. Stanley,
Chemist, Sewage Disposal Plants,
City.

Dear Sir:

Several years ago, when the concrete sewers leading from the Willow Street pumping plant to the North Side Disposal Plant, and from the Scott Street pumping plant to the South Side Disposal Plant were being designed, we were told by interests in competition with concrete sewers that these lines in a course of four or five years, in all probability, would be so badly disintegrated that complete failure might be expected, with the reconstruction of same.

Now, as the lines have been in use since the early part of 1917, carrying almost the entire flow of sewage produced in the city, and as a quantity of approximately eight million gallons per day, or a total quantity of 18,250 millions of gallons, have flowed through these sewers,and as the time in use is about 50% in excess of that given as the life of these sewers by competitors of concrete, and as, in my opinion, sufficient time has elapsed since they have been in use to clearly determine what action, if any, the sewage is having upon the concrete, and as the proper chemical analysis will not only show that past action, but should be indicative as to the future action, I will request that you make a most complete investigation, both physical and chemical, as outlined below, giving me a report at your very earliest convenience.

In making this investigation, I want you to keep in mind the importance of a reliable report, and to leave nothing uncovered that will throw any light upon the conditions, as it is the unbroken policy of this Department to recommend only materials of a high standard, and any conclusions drawn from an incomplete report might prove to be very serious. I urgently request the completeness of the investigation as follows:

1. It is claimed that concrete, being of a calcareous nature, is affected by the acids directly in the sewage.

2. That it is affected by acids formed indirectly by the decomposition of sewage, during which process hydrogen sulphide may be generated and given off into the air in the sewer, where it is by the air and moisture oxidized to sulphuric acid, and coming into intimate contact with the concrete, has a deleterious action.

3. That the concrete may be disintegrated from the inside by a sewage of strongly alkaline content, or from the outside by a ground water of strongly alkaline reaction percolating through the wall of the sewer.

4. You have in the past twelve months made a number of absorption tests on concrete sewer pipe now being manufactured under City specifications, I would also request your conclusions as to this class of pipe resisting the various alleged deleterious chemical actions as compared with the sewers covered by this investigation.

After you have made the necessary investigations, I not only would like to have the details of same, but your conclusions as based thereon, coupled with your experience as a chemist both in America and the European countries.

Yours very truly,
G. L. Fugate,
Principal Assistant City Engineer.

Mr. G. L. Fugate,
Principal Assistant City Engineer,
City.

Dear Sir:

In accordance with your request of August 31st, I have completed a very thorough inspection and chemical analysis in connection with the condition of the 42-inch and 36-inch concrete sewers between the pumping and disposal plants, of which a report and my conclusions follow:

1. Acid Directly in Sewage

It occurs to me that this item could be entirely eliminated from this investigation, as an acid sewage does not exist in Houston, or any city of which I have records. As the sewage of a city is usually composed of about 98.8% of water from the city's water supply, and as water supplies are alkaline in reaction and not acid, it naturally follows that the sewage will be alkaline. Of course there are a few industrial wastes, such as waste from paper pulp mills, wire and other galvanizing factories, that may show an acid reaction, but this is usually quickly neutralized upon coming in contact with the alkaline sewage.

I have personally made several thousand tests of the sewage received at the Houston disposal plants, and I have available tests since 1914, none of which reveal a single acid reaction.

2. Acid formed Indirectly by the Oxidation of Hydrogen Sulphide

Compounds of sulphur are always, to some extent, present in domestic sewage, but the quantity that may be derived from vegetable or organic matter is usually small. The chief sources are sulphates of calcium and magnesium dissolved in the water supply and sulphates and sulphides of the alkalies.

Hydrogen sulphide is a gas formed by the decomposition of matter containing sulphur, or by reduction of sulphates and the resulting sulphides decomposing with the formation of hydrogen sulphide. The characteristic odor of a rotten egg is due to this gas.

As sulphur in some form must be present before hydrogen sulphide can be formed, the quantity must therefore be dependent upon the original amount of sulphur. As the sewage of this city is low in sulphur content, the amount of hydrogen sulphide formed must be negligible. It does not necessarily follow, however, that hydrogen sulphide will be formed in decomposing sewage, even if sulphur is present, as the affinity of iron for sulphur is great, any iron present will combine forming sulphide of iron, which remains intact and does not split up with the formation of hydrogen sulphide.

When hydrogen sulphide gas is formed, it is not impossible that it will collect along the sides of the sewer above the water line, but as long as it remains dry no damage will result, but upon coming in contact with moisture, it may oxidize, forming sulphuric acid which has a deleterious action upon concrete. To determine if this has taken place, the sewers have been examined and specimens of concrete analyzed, also samples of the matter adhering to the walls just above the high water line which contained moisture were tested for an acid reaction; in no case did acid exist.

The analyses of the concrete are given in Table No. 1, the results of which show that disintegration has not taken place.

Particular attention was paid to the condition of the concrete at the point where the sewage is discharged from the Scott Street pumping plant. For the first year or so after this plant was placed in operation, a very septic sewage (an ideal condition for formation of hydrogen sulphide) was handled, due to the small quantity passing through the large lines at a low velocity. The churning action of the pumps and the agitation at the point of discharge would have a tendency to liberate large quantities of gases that might be entrained in the sewage, and if disintegration is to be expected, it certainly would occur at this point. While making my investigation, the pumps were stopped, and a minute examination made of the entire sewer section, and samples collected of moisture and concrete. The visual examination did not reveal the least signs of disintegration, the moisture was not acid; and the chemical analysis of the concrete shows that no change has taken place.

As this sewer had been in operation for over six years, in order to determine the effect of a greater time factor, a sample of a concrete mortar joint was removed from the clay pipe in the Alabama Avenue sewer, which is under repairs near Jack Street. Although this sewer has been in operation twelve years, the mortar does not show signs of disintegration. The same action will occur on mortar joints in clay pipe as in the body of concrete sewers.

Another inspection was made, this at the Houston Heights pumping plant. The concrete receiving pit has been used for the storage of sewage for a number of years, the flow being stored for twenty-four hours. There is no evidence of disintegration of the concrete at this plant.

TABLE NO. 1

(Cement analyzed for anhydrous sulphuric acid (SO_3) the limit of which is 1.75% in original cement. If disintegration is taking place, it will be shown by an excess of this quantity.)

Average for North Side Line	1.32% SO_3
Average for South Side Line	1.49%
Mortar from Joint in Alabama Sewer	1.28%
Concrete from Building at N. S. Plant	1.45%
Unused Concrete Sewer Pipe	1.52%
Mean for Cement in Contact with Sewage	1.40%
Mean for Cement Not in Contact with Sewage	1.49%

3. DISINTEGRATION BY ACTION OF ALKALI

In my opinion this part of the investigation could also have been eliminated, but, carrying out your instructions, I have gone into this phase very carefully by inspections and chemical analyses of the city water supply, surface supply, shallow ground supply, and sewage, the results of which are given in Table No. 2.

Alkali deposits are not usually found in regions with heavy rainfall, and in this locality with an annual rainfall of 4 feet, the soluble salts have been leaching out of the soil for centuries, until the waters now contain only a few hundred parts per million total alkalinity; and of the sulphate type, the type which causes disintegration of concrete, the amount is negligible.

Your attention is called to the Technologic Paper No. 214, issued by the Bureau of Standards, United States Government, on "Durability of Cement Drain Tile and Concrete in Alkali Soils" and the conclusions.

I will briefly state that the Bureau has carried on investigations of this nature for ten years, testing concrete and concrete pipe placed in the heavy alkali deposits of the Western states, and have concluded that strong alkali will disintegrate the best mass concrete or concrete pipe, but that the danger zone does not begin until the waters or soil contains 1000 parts per million of the salts of the sulphate type. The most we have found locally of this type is only 32.2 parts per million in the water from Buffalo Bayou at Shepherds Dam.

TABLE NO. 2
WATER AND SEWAGE ANALYSES
(Results in Parts Per Million)

Sampling Location	Source	Total Alkalinity	SO_3
Near Santa Fe and G.H.& S.A. Crossing	Deep Wells	360	21.6
Buffalo River at Shepherds Dam	Surface and Springs.	504	32.2
City Mains in Houston Heights	Deep Wells	476	31.0
Brays Bayou at Dixie Avenue	Surface and Springs.	374	21.0
Park Place Mains	Deep Wells	352	19.8
Sims Bayou Galveston Road	Surface and Springs.	328	9.8
City Mains at N. S. Disposal Plant	Deep Wells	402	18.8
City Sewage		372	21.8

4. PERMANENCE OF CONCRETE SEWER PIPE COMPARED WITH CONCRETE SEWERS OF LARGER SIZE

The Bureau of Standards reports that "these tests suggest that permeability rather than porosity or density may be a criterion of resistance," and that differences in permeability are due in part to a greater cement content and in part to a greater quantity of water used in mixing the concrete. The larger size sewers which we have examined for this report are not quite as rich a mixture as is used in the manufacture of the smaller sizes, but a wetter consistency perhaps was used, and just where these two factors will balance has not been determined, but I am of the opinion that concrete pipe manufactured in accordance with the specifications and City requirements will be as fully resistant to any chemical action as the sewers investigated.

CONCLUSIONS

Based upon my investigation, the following conclusions are derived:

1. The sewage of Houston is not acid, therefore deterioriation caused by acidity directly in the sewage is impossible.
2. The investigation reveals that acid is not being formed by the oxidation of hydrogen sulphide, even under the most favorable conditions for the liberation of the gas.
3. The safety factor between the alkali content of the ground water and sewage, and the zone of danger is so large that deleterious action by alkali is not probable.
4. The sewers examined are in first-class condition, which is actual proof of the foregoing conclusions.

Yours truly,
W. S. STANLEY,
Chemist, Sewage Disposal Plants.

Cost of Laying Concrete Block

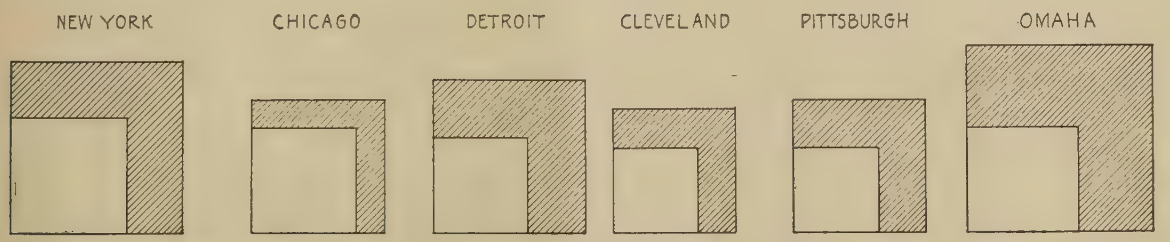
BY A. J. R. CURTIS

In days gone by, when a large proportion of concrete block production came from "back yard" plants, lack of business stability was often sufficient to prejudice buyers against the products, no matter how good the quality or how great the economies to be obtained by their use. Today, with over 80% of a record-breaking output being manufactured by 20% of the total number of plants, manufacturers' dependability can be counted on almost everywhere, quality of block is moving toward a satisfactory stable standard, and old prejudices against the concrete block are rapidly passing.

Builders in many sections are praising concrete block for the handy size of the standard unit and for the very noticeable saving in the cost of laying, as compared with the cost of laying brick. This economy in laying is, of course, well known to those contractors who regularly compare their own figures with those of brick masonry contractors in the same locality, but it will be interesting and perhaps helpful to the readers of CONCRETE to glance over the appended table comparing laying cost of these two competitive units in various parts of the country.

In order to get a fair general comparison, the writer invited 300 concrete products manufacturers to supply figures showing the number of clay brick and concrete block laid per day in their respective communities, and replies were received from over 200 manufacturers, a considerable number of them builders as well. The results have been condensed in order to simplify them, and, unfortunately, about fifty reports could not be used because they contained incomplete data.

These reports, which, from the nature of the case, must be accepted typical rather than actual, present



COMPARATIVE WALL VOLUMES OF 8-INCH COMMON BRICK AND CONCRETE BLOCK MASONRY LAID PER DAY.
Volume of common brick shown in white squares, shaded portions represent additional volume laid without extra cost by using concrete block masonry.

sufficient evidence to indicate unquestionably, the money-saving opportunities in laying concrete block. The reports show that the number of clay brick laid per day in the communities reporting varies from 500 to 2500. Both of these figures may represent incomparable extremes, although all were reported for work on double brick walls (common brick) first story above grade. The greater number of reports would indicate, however, that 800 to 1500 brick are being laid today in common practice.

The table also shows that from 75 to 400 standard 8 x 8 x 16 block are being laid in first floor work, but about 62% of the reports used in the table show that from 200 to 300 block are laid per day in the territory represented.

One fact seems clearly proven by the table and accompanying diagram: Block *are* cheaper to lay than are brick. From a great majority of the reports, block are much cheaper to lay. Savings of from 20 to 50% are commonly reported. These figures mean no small amount when translated into terms of our annual construction bill for the country. To the prospective builder they may mean a snug and worthwhile saving by a simple and satisfactory "switch" to concrete block.

COMPARISON OF COST OF LAYING CONCRETE BLOCK AND CLAY BRICK MASONRY

		Common Brick Laid Per Eight Hour Day	8x8x16" Concrete Block Laid Per Eight Hour Day	Common Brick Required to Equal Wall Volume of Concrete Block	Ratio of Wall Volume of Concrete Block to Common Brick Laid Per 8-Hour Day	Relative Labor Cost to Lay 8" Concrete Block Wall Compared to Equal Volume Brick Wall
Ala.	Fairhope	1,000	200	2,600	2.60	38.5%
Calif.	Holtville	1,000	75	975	.975	105.0%
"	Lodi	1,000	175	2,275	2.27	44.0%
Del.	Wilmington	800	200	2,600	3.25	37.0%
Fla.	Daytona	1,500	200	2,600	1.73	57.7%
"	Miami	1,200	200	2,600	2.17	46.0%
Ill.	Benton	800	250	3,250	4.06	24.6%
"	Centralia	800	225	2,925	3.66	27.3%
"	Chicago	1,200	150	1,950	1.62	61.7%
"	Danville	1,500	200	2,600	1.73	57.7%
"	Granite City	800	200	2,600	3.25	30.7%
"	Mobile	1,200	250	3,250	2.71	35.9%
"	Oak Park	1,200	150	1,950	1.62	61.7%
"	Peoria	1,100	180	2,340	2.13	46.9%
"	Rockford	1,200	190	2,470	2.05	48.7%
"	E. St. Louis	1,600	200	2,600	1.62	61.7%
Ind.	Gary	1,100	250	3,250	2.95	33.9%
"	Indianapolis	1,000	350	4,550	4.55	22.0%
"	Hammond	1,200	225	2,925	2.43	41.1%
"	Fort Wayne	800	200	2,600	3.25	37.0%
"	South Bend	600	135	1,755	2.92	34.2%
Iowa	Council Bluffs	1,200	250	3,250	2.71	35.9%
"	Davenport	800	300	3,900	4.88	20.5%
"	Red Oak	1,700	275	3,575	2.1	47.7%
Ky.	Ashland	1,100	225	2,025	1.84	54.4%
"	Covington	1,100	300	3,900	3.54	28.2%
"	Lexington	1,100	275	3,575	3.25	37.0%
Mass.	East Boston	1,200	250	3,250	2.71	35.9%
"	Springfield	1,000	175	2,275	2.27	44.0%
Mich.	Detroit	1,000	200	2,600	2.6	38.5%
"	Galien	1,200	150	1,950	1.6	62.5%
Minn.	Parkers Prairie	1,500	300	3,900	2.6	38.5%
Nebr.	Howells	2,000	150	1,950	.975	105.0%
"	Omaha	1,200	300	3,900	3.25	31.0%
N. J.	Atlantic City	1,200	200	2,600	2.17	46.0%
"	East Orange	800	250	3,250	4.06	24.6%
"	Egg Harbor City	800	150	1,950	2.44	41.0%
"	Millville	1,000	200	2,600	2.6	38.5%
"	Woodbury	700	400	5,200	7.4	13.5%
"	Woodlyn	800	200	2,600	3.25	31.0%
N. Y.	Brooklyn	1,200	250	3 250	2.7	36.0%
"	Jamaica	1,000	250	3,250	3.25	30.7%
"	Middletown	800	100	1,300	1.6	62.5%
"	Newburgh	1,000	250	3,250	3.25	31.0%
"	New York	1,500	250	3,250	2.17	46.0%
"	Ogdensburg	500	100	1,300	2.6	38.5%
"	Watertown	800	125	1,625	2.03	49.2%
Ohio	Cleveland	800	130	1,690	2.05	48.7%
"	Columbus	2,000	230	2,990	1.5	66.6%
"	Lorain	1,200	300	3,900	3.34	30.0%
"	Pandora	1,250	150	1,950	1.56	64.4%
"	Toledo	2,000	190	2,470	1.24	80.6%
Ore.	Corvallis	1,000	225	2,925	2.92	34.2%
"	Eugene	1,200	225	2,925	2.44	41.0%
"	Portland	800	75	975	1.22	83.2%
Pa.	Allentown	850	150	1,950	2.3	43.4%
"	Bethlehem	800	200	2,600	3.25	30.7%
"	Dorranceton	700	200	2,600	3.71	26.9%
"	Erie	1,000	190	2,470	2.47	40.4%
"	Grove City	1,200	250	3,250	2.7	36.0%
"	Lancaster	800	350	4,550	5.68	17.6%
"	Lemoyne	800	200	2,600	3.25	37.0%
"	Lewisburg	800	130	1,690	2.11	47.3%
"	Lewiston	800	300	3,900	4.87	20.6%
"	Monaca	2,500	200	2,600	1.04	96.1%
"	Newcastle	1,000	200	2,600	2.6	38.5%
"	Oakmont	1,000	125	1,625	1.62	61.7%
"	Pittsburgh	800	150	1,950	2.44	41.0%
"	Sayre	750	100	1,300	1.73	57.7%
"	Springdale	700	300	3,900	5.57	17.9%
"	Stroudsburg	900	240	3,120	3.46	28.9%
"	Wesleyville	1,000	200	2,600	2.6	38.5%
"	Wilkes Barre	800	200	2,600	3.25	30.7%
"	Williamsport	900	100	1,300	1.44	69.4%
"	Wyoming	850	200	2,600	3.06	32.6%
"	York	600	250	3,250	5.41	18.3%
W. Va.	Huntington	1,000	600	7,800	7.8	12.8%

Ready-Made Concrete Roofing

A Letter from H. J. Harms

Some time ago I visited the works of the N.V. Betondak at Arkel, Holland (Betondak: concrete roof; Arkel, a little village a few hours from Rotterdam, near Gorinchem). I went there especially to examine the roofing system manufactured by this firm, exploiting the process of the German firm, Friedrich Remy Nachf. The material used is cement, river sand and "bimsand." The latter material is of volcanic origin, comes from Germany and is very porous and light. For the purpose, it is finely ground and mixed with the sand in definite proportions before being mixed with the cement. The exact proportions were not disclosed to me.

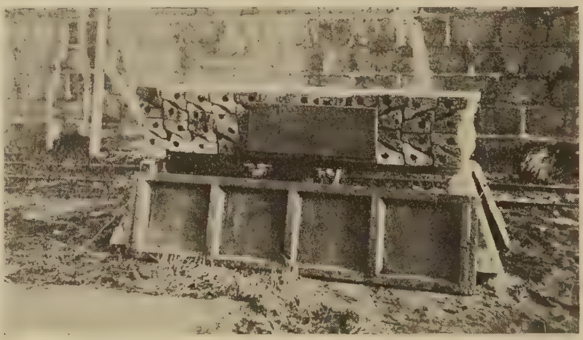


Fig. 1—Section of Concrete Roofing Showing Molded Bottom Edges

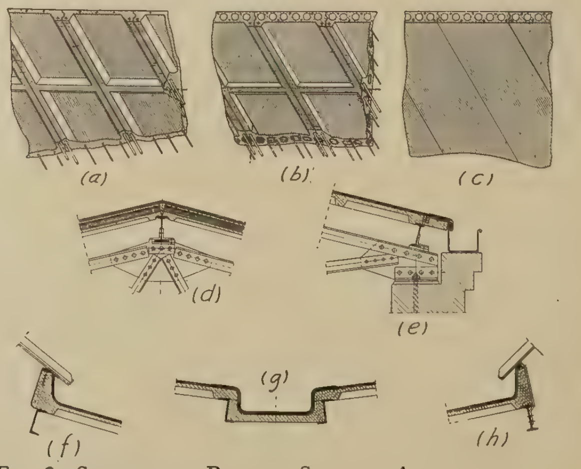


Fig. 2—Sections of Roofing Showing Arrangement at Ridges and Gutters

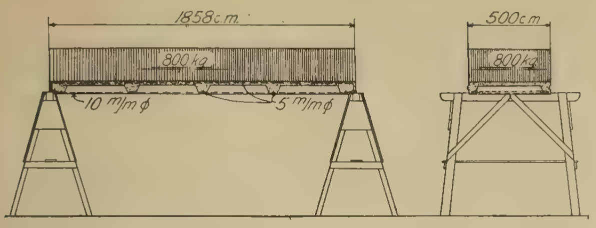


FIG. 3—METHOD OF TESTING PRECAST SECTION

As will be seen from the illustrations, the roof is made up of paneled sections some 50 c. m. wide and of a length to suit the distance between purlins, up to 3 meters. The panels are reinforced in the long edges generally with one 9-m.m. rod, while a few light rods are placed in the paneled part, to allow for expansion. The standard sections are shown in Fig. 2A, but frequently channeled sections are used, as in Fig. 2B and 2C, either paneled or of equal thickness throughout. It is said that the channeled system is preferred by some architects on account of its better insulation against temperature changes.

Fig. 1 shows clearly the molded bottom edge of the section with which it rests on the purlins; thereby preventing these from moving sidewise.

For molding, ordinary wooden forms are used. A very dry mix is used, the material being mixed in pan and roller mixers. Once in the mold, it is thoroughly tamped. Dismantling is done within a few hours and the sections placed in ovens, heated with moist steam, where they remain for three or four days and are then air dried outside for 4 weeks at least.

Asking why such a dry mix was used, I was answered that they quite realized the advantages of wetter mix, but that this would require a much greater number of molds, as rapid dismantling would then be impossible. Otherwise, nothing prevented them from using more water.

The writer, while there, assisted at a test of some special sections. Fig. 1 shows a photograph taken at that occasion. The roof section in Fig. B is paneled of "bimsbeton" (concrete of "bimsand"). The end ribs of the section are 8 c. m. wide and 5 high. The paneled section is 25 m. m. thick. The longitudinal edges are each reinforced with one 10-m. m. round, while the traverse ribs each contain one 5-m. m. round, as also the panel sections. Load: 800 kilos. Area: 1.858 x 0.50=.929 sq. m. Thus: load per sq. meter, 862 kilos. Deflection during the load, 8. m. m. After unloading, nihil. The tested plate was chosen at random by the writer from a pile and the age was four weeks.

The company's catalog gives plenty of illustrations of these roofs and the company has not had any complaints so far. The roof plates are not waterproof themselves and generally, a ready-made roofing is applied, Texaco roofing or other; also asphalt paper in two or more layers, applied with asphalt.

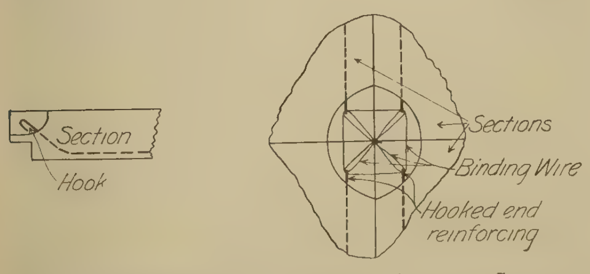


FIG. 4—DETAILS OF METHOD OF BINDING ADJOINING SECTIONS AT CORNERS

In molding, the upper corners are kept free, leaving the hooked ends of the bent-up rods exposed. Once the sections are in place on the purlins, the four sections meeting at the corners, are connected by passing binding wire through the hooked ends of the rods, and then the hole is filled with cement-mortar. The whole roof in place, the joints are poured full with cement-grout.

In case lifting of the roof by strong winds should be possible, as on station-sheds, some of the sections are fastened to the purlins by means of hooked bars, the hook gripping under the purlins, and the other end, threaded, passing through a cored-out hole in the section. On this thread a nut is placed, which is screwed tight, the rod then sawed off and the hole filled with mortar.

The construction at the ridges does not offer any difficulty, and here also the sections from the two sides are tied together, after which the space is filled with mortar, which also forms the ridge. Gutters are sometimes made of galvanized iron, but generally of the same bimsand-concrete, in precast sections. These are shown in Fig. 2, (d) to (h).

At present the system is being extended to the construction of curtainwalls, fences, and sidewalks for iron railroad and other bridges. In the latter case, the walk is finished by placing a layer of cement-mortar ¾-in. thick on top of the sections, or sheet-asphalt or asphalt-concrete.

The advantages of the system over other concrete construction are the relative light weight (1500 kilos per cubic meter), its good insulation against temperature changes and its rapid erection. Further, it has an advantage in case of wrecking of the building, or necessity for taking up part of the roof, for changes, etc. The sections are easily taken up and can be used over again, if handled with ordinary care.

As to price, the cost in Holland is about the same as for a concrete roof, made in place; but on account of the lighter weight of the roofing a considerable saving in the steel framework can be effected.

Concrete Tile Alkali Tests

Fifteen hundred feet of experimental concrete tile has been made up by University of Minnesota men, who are cooperating with the United States Department of Agriculture and the Minnesota State Department of Drainage for the purpose of developing a tile that will endure in various types of alkalin soil. The tile has given satisfactory results under severe laboratory tests, conducted at University Farm, St. Paul, by D. G. Miller, engineer, who represents the U. S. department and is in charge of the work.

Some of the tile has already been installed, or soon will be, near Marshall, Lyon county, Minn.; at Bitter Medicine Lake, 20 miles from Watertown, S. D., a lake shore so strongly impregnated with alkali that scarcely anything will grow there; and in alkalin soil near Enderlin, N. D. Some of the tile, which will be used to check up the field experiments mentioned, has been laid on the university's farm, St. Paul.

Sections of the tile will be dug up every year for inspection and study. This is the first of a series of tests under field conditions which the three cooperators, university, state, and government, are planning to make in the northwest.

Winter Construction Costs Less

Winter construction is often urged as a means of solving the seasonal employment problem. But building investors are not always swayed by altruistic motives. They are not so much interested in economics as in their own economies. It appears from testimony offered at the Winter Construction Meeting of the New York Building Congress, held Nov. 21 at the Hotel Commodore that winter construction of reinforced concrete buildings means savings to the owner not only by earlier occupancy but actual cash saving in building cost.

W. J. Barney, president of the Barney-Ahlers Construction Co., placed himself on record that "More winter construction is the acknowledged remedy for seasonal unemployment in the building industry" and he followed up this general statement with interesting cost records.

"You have been told forcibly of the social and economic evil of seasonal unemployment for the carpenters, the bricklayers, in fact for all those who directly do the work of our industry," said Mr. Barney, "and to many this problem of seasonal employment seems to be solely a picture of its hardship to the mechanics and workers in the various trades. This is but the sharp foreground of the picture, its larger background shows that where the mechanic is unemployed, also is unemployed the contractor, material manufacturer, the architect and all others involved in our great industry—we one and all suffer from this curse of seasonal variation in the volume of our business, and finally in the horizon you see the public paying during the period of intense activity, higher wages, higher prices and larger fees to compensate for the period of enforced idleness during which the mechanic must live on his savings, the contractor carry his overhead, the architect maintain his staff, and the material manufacturer offset his plant investment and factory overhead.

"In short, this is not a problem whose solution will be beneficial to mechanics alone, but is one in which all sections of this Building Congress are vitally interested and to which they could all well afford to contribure liberally for its solution through the more even distribution of construction throughout the entire year.

"To effect this will require our utmost efforts, for the obstacles in the way are perhaps the hardest of all to overcome, namely tradition and business habits in persons. Many things may be difficult to accomplish but among the most difficult are to change men's beliefs, habits and traditions. From the beginning of history it has been traditional that when cold weather set in with frost, snow and sleet, construction should cease until the coming of spring. Until the coming of steam heat, winter meant freezing, frost and damage, except as guarded by open fires, always dangerous, especially around open construction work. Until the coming of electricity, winter meant shorter working days with low efficiency and suffering from cold. Until modern machinery was developed for wholesale and large quantity production, big operations relied upon a multiplicity of human hands, always less efficient, less sure in biting winds and chills of winter. In short, up to the time of our own childhood we had all been taught that construction could not be profitably, efficiently or satisfactorily carried on in winter so that today, when modern science, through machinery and equipment and protection, have rendered winter weather construction as efficient, comfortable and rapid as summer work. We still find construction policies dictated and determined by age long traditions, that spring, summer and early fall are the times for active building.

"Consequently all the tremendous organization, plant and equipment invested for this work, is permitted to lie idle, or practically so, for one-third of the year. One of the unpardonable crimes and follies of modern life is this tax on every form of endeavor that must be housed in homes, factories, offices, schools or any type of building. To my mind, the only effective correction for this condition is intensive publicity and education towards the general public, and those who control the building policy of financial institutions so they will thoroughly understand that under modern conditions they can build efficiently and economically at all times during the year—in fact, under present existing conditions, more economically and efficiently in winter than in summer.

"From our files, I have taken three typical contracts, and the amounts given under the total contract column are for the reinforced concrete structure, the enclosing walls, sash and roof, in other words, for that part of the building which requires protection from winter winds, freezing and cold in the course of construction. Once the building is enclosed, the matter of heating for the finishing trades is comparatively simple, especially if the permanent heating plant has promptly followed up the structural work. You will note that in a general way, about five percent of the contract represents the cost for winter protection.

Total Contract	Time of Protection	Cost of Protection	Percentage Costs
$263,000.00	Dec.-Jan.	$13,000.00	5%
180,000.00	Dec.-Jan.	8,800.00	4½%
95,000.00	Jan.-Feb.	6,300.00	6½%

"This however, does not represent the true cost of winter construction, as the cost of this winter protection, especially under present conditions of the labor and material markets,are more than offset by the lower cost of materials during the winter, the absence of bonuses paid to mechanics, the greater efficiency of mechanics under conditions when work is not so plentiful.

"Take the past year for example, we find lumber cost approximately 10% less when purchased in November than in June. We find that roofers or ¾-in. boards, which enter so largely into form construction, are purchased for one dollar per thousand less in November than in August. We find that common brick entering into the curtain walls is purchased for $3 less per thousand in November than in August. We find that reinforcing steel is purchased for 7 cents per hundred pounds less in November than in August and we all know that cement has had its seasonal drop.

"It is a matter of common record that during the past summer bricklayers were paid $14, $16 and $18 and even as high as $20 a day, cement finishers were paid as high as $15 per day, carpenters frequently received bonuses of from $2 to $3 dollars per day, that all labor was scarce, difficult to obtain and very naturally, not working at full efficiency under such conditions. We know that it is now possible to obtain practically all labor and skilled mechanics, especially in the reinforced concrete construction, at the established union rates, and that the men are anxious and willing to work efficiently and skillfully and have a direct interest in holding their positions.

"A still more vital factor to be weighed is the selling psychology of the general contractor which always follows a definite seasonal trend. In the spring and summer when work is plentiful, the general contractor and the special contractor will invariably place upon his work, a considerably larger margin of profit and contingency, justifiably so against the sky-rocketing of summer costs. In the fall when work begins to become scarce and the contractor is confronted with the problem of holding his organization together during the winter months, he will invariably lower his percentage of profit and take work on a closer basis as to contingencies, appreciating that he will be able to manage, control and direct his work far more efficeintly during the winter months than in the summer; and, consequently, can operate safely upon a closer margin than when he does not know from week to week, as during the summer months, whether mechanics wages will increase $2, $4, $6 or $8 per day. I have had our estimating department take from its files typical estimates, and, using these various factors, the same building would have been estimated by us in August at $208,000 and today for winter construction at $203,000, showing a saving to the owner of at least $5,000, or 5%, this including all cost of winter protection. Therefore, under present labor and material conditions, it is certainly conservative to say that winter construction costs no more than summer work."

Reinforced Concrete Proved Its Efficiency in Japan

(Continued from page 224)

damage. Figs. 4 and 7 show good examples of this type of structure. About 70 of them received no damage from the earthquake, but they caught the fire later, and the interiors were completely burnt out. Thirty such structures were either destroyed by the earthquake or burnt down by the fire to such extent that there is no hope of repairing them for further use.

Causes of failure of these buildings are so many and so interwoven with each other that we cannot attribute the failure to any one cause. Generally speaking, the damage due to vertical movement of earth during the quake was very little, most of the injury coming from the horizontal movement. In one group the weak point was in foundations, and the partial settlement or irregular slipping of such footings was evidently the main cause of total failure. The best type of foundation for the earthquake district is the raft foundation, particularly when we meet the soft ground. For example, the Imperial Hotel came through intact, even though it had shown settlement of more than one foot as a whole before the earthquake. The raft foundation under it should have had a big role in making this structure rigid against lateral force, though there were also many other favorable conditions. The continuous footing might be used on good soil. Isolated footings should be avoided whenever possible, even if they are to be connected with strong tie beams. Shallow foundations did not give good results. It is fundamentally wrong to build structures partly on fill and partly on natural ground. Partial settlement is not the only thing to be feared in such cases. Soft and hard ground will not move together, and such difference in movement of earth might cause a torsional effect on the building above. Raft foundations with short piling would be the best solution for such cases. Keeping in mind the violence of the horizontal shocks, no spliced pile should be allowed. Another group had the weak point in the column. Practically no building collapsed due to weakness in the floor system. Nearly all failures started in columns, particularly when there was no partition wall to brace the building against the lateral force. Several factory buildings, with their exterior wall consisting of columns and glass windows only, suffered severely. Fig. 3 shows an example of such a failure.

The most efficient system to strengthen the building against the lateral force is the use of an ample number of strong partition walls, else the column section should be made large enough to take all bending and direct stresses. In future, owners of such factories will have to arrange their manufacturing process so as to allow their floor space to be cut up into smaller units by strong partitions.

Roofs and floors should be made as light as possible, without sacrificing other equally important qualities, such as fire-proofness, permanence, etc. The reason for this is, of course, that if floors and roofs are made light, the walls and columns will have smaller stress due to lateral force. For the same reason we should avoid heavy parapet walls, heavy cornices and other unnecessary ornamentation. These parts are also dangerous when they break off and fall down.

Another, and not the least important, feature is workmanship. I believe that many buildings, which otherwise would have stood, were wrecked because poor workmanship allowed failure to start at some weak column or wall, thus throwing additional strain on the adjacent parts and allowing failure to proceed progressively until the whole came down.

Close observation of wrecked buildings reveals many defects in execution. In many cases concrete was not mixed well, resulting in honeycomb work. Particular attention is invited to the fact that column concrete is rather poor just above floor line where its greatest strength is required. This evidently due to difficulty of rodding concrete through narrow, deep formwork. Another common defect was the misplacing of reinforcing bars. In one case, the column rods were set too far from the face. In another case, the rods in layers were not spaced to each other, one layer being placed directly over the other. Still another example shows the bent up bars set upside down. These and other defects in workmanship can be avoided only when the reliable contractor is induced to cooperate with the experienced inspector. Only by so doing, the true interest of the building owner and the public be served.

According to the experience of the last earthquake, wire glass stood the test much better than steel shutters. In many places the earthquake threw the steel shutters out of line, causing them to stick, and making it impossible to shut them before the fire came. Even where the shutters were lowered, the heat buckled the steel and allowed the flames to come through. While in buildings where wire glass was used throughout, practically no harm was done, even in the heart of the hottest fire.

Investigation of roofing material in burnt area, reveals the fact that where asphalt roofing was used and was not protected by cement or tile, the roofing was seriously damaged. To cover the roof with asphalt and gravel only is not a good practice.

A New Cinder Concrete Fireproofing Tile

A new cinder partition tile is being made in Long Island City, N. Y. It is being perfected by William Keppler, 1799 First Ave., New York city. The new unit is to be used for protection around steel columns, and also for partitions, and is made in a section 2 in. thick by 12 in. x 12 in., with four air slots about 1/4 in. to 3/8 in. × 1 1/2 in. The unit has passed the building departments of Queens and Manhattan for fireproofing work.

Trend of Costs for Concrete Buildings 1914 to 1923

Here is an analysis of reinforced concrete building costs, figured at frequent intervals, by the Aberthaw Co., Boston, from 1914 to Nov. 1, 1923. They are based on a building area of 88,250 sq. ft. and 1,145,000 cu. ft.

COST OF BUILDING INDEX-ANALYSED

	1914	Dec. 31 1920	Mar. 1 1921	Apr. 1 1921	May 1 1921	June 1, 1921
Concrete	$ 36,490	$ 96,616	$ 83,327	$ 78,684	$ 73,598	$ 70,973
Forms	17,080	32,984	25,772	21,851	20,375	20,195
Reinforcement	13,352	33,650	25,620	23,770	23,720	23,720
Excavation	3,600	8,860	6,898	6,018	4,850	4,850
Tile and plaster	3,539	8,720	6,705	6,455	6,455	6,455
Sash and glazing	5,841	16,620	12,300	11,250	11,250	11,250
Doors	1,014	2,485	2,004	2,004	2,004	2,004
Miscellaneous iron	4,067	9,027	6,773	6,791	6,779	6,779
Roofing, flashing & vents	1,121	2,750	2,300	2,248	2,248	2,248
Wood walk on roof	28	70	58	58	58	58
Painting	797	1,955	1,630	1,630	1,630	1,630
Liability insurance	2,100	4,400	4,000	4,000	4,000	4,000
Engineering, plans supt., etc.	3,574	6,020	6,020	6,020	6,020	6,020
	$ 92,603	$224,157	$183,407	$170,779	$162,987	$160,182

	July 1, 1921	Aug. 1, 1921	Sept. 1, 1921	Oct. 1, 1921	Nov.-Dec., 1921	Jan. 1, 1922
Concrete	$ 68,024	$ 68,024	$ 68,024	$ 65,574	$ 61,041	$ 60,561
Forms	20,293	20,293	19,973	19,833	19,498	19,498
Reinforcement	24,200	22,534	22,100	21,680	20,638	20,638
Excavation	4,800	4,050	4,050	4,050	3,318	3,318
Tile and plaster	7,340	7,340	7,340	7,340	7,230	7,230
Sash and glazing	10,215	9,194	9,194	9,194	9,194	8,580
Doors	1,712	1,712	1,712	1,712	1,712	1,712
Miscellaneous iron	6,282	6,282	6,282	6,282	6,317	5,857
Roofing flashing & vents	2,220	2,220	2,220	2,220	2,220	2,220
Wood Walk on roof	58	58	58	58	58	58
Painting	1,600	1,600	1,600	1,600	1,600	1,600
Liability insurance	3,300	3,300	3,300	3,300	3,300	3,300
Engineering, plans, supt., etc.	6,000	6,000	6,000	6,000	6,000	6,000
	$156,044	$152,607	$151,853	$148,843	$142,126	$140,572

	May 1, 1922	June 1, 1922	July 1, 1922	Aug. 1, 1922	Sept. 1, 1922	Oct. 1, 1922
Concrete	$ 61,211	$ 66,362	$ 66,514	$ 67,733	$ 74,806	$ 75,616
Forms	20,072	21,965	21,974	22,642	23,907	24,007
Reinforcement	22,500	25,534	26,266	27,091	31,441	31,441
Excavation	3,550	3,897	4,378	4,584	4,732	5,022
Tile and plaster	7,563	8,372	8,019	8,019	8,471	8,471
Sash and glazing	9,420	9,905	10,115	10,301	11,333	11,333
Doors	1,712	1,853	1,854	1,854	1,959	1,959
Miscellaneous iron	6,027	6,415	6,417	6,520	6,612	6,612
Roofing, flashing & vents	2,220	2,317	2,318	2,318	2,350	2,350
Wood walk on roof	58	62	62	62	62	62
Painting	1,500	1,544	1,545	1,545	1,567	1,567
Liability insurance	*3,300	2,162	2,163	2,163	2,403	2,403
Engineering, plans, supt., etc.	6,000	6,177	6,180	6,180	6,267	6,267
	$145,133	$156,565	$157,805	$161,012	$175,910	$177,110

	Nov. 1, 1922	Dec. 1, 1922	Jan. 1, 1923	Feb. 1, 1923	Apr. 1, 1923	June 1, 1923
Concrete	$ 75,685	$ 74,056	$ 75,924	$ 77,415	$ 79,307	$ 81,235
Forms	24,396	24,670	24,388	25,352	26,415	26,292
Reinforcement	30,973	30,975	30,450	32,190	36,958	36,787
Excavation	5,266	5,266	5,266	5,470	5,926	6,328
Tile and plaster	7,205	7,205	7,205	7,389	7,394	7,703
Sash and glazing	12,022	12,023	12,023	12,330	11 007	11,422
Doors	2,230	2,230	2,230	2,287	2,289	2,278
Miscellaneous iron	6,646	6,646	6,646	6,816	6,821	7,003
Roofing, flashing & vents	2,362	2,363	2,363	2,423	2,424	2,574
Wood walk on roof	63	63	63	65	65	64
Painting	1,575	1,575	1,575	1,615	1,616	1,609
Liability insurance	2,415	2,415	2,415	2,477	2,586	2,574
Engineering, plans, supt., etc.	6,300	6,300	6,300	6,461	6,465	6,435
	$177,138	$175,787	$176,848	$182,290	$189,273	$192,304

	July 1,	Aug. 1,	Sept. 1,	Oct. 1,	Nov. 1,	
Concrete	$ 81,234	$ 80,563	$ 80,563	$ 80,410	$ 79,849	
Forms	26,184	27,573	27,573	26,730	26,543	
Reinforcement	35,177	35,524	35,524	34,980	34,290	
Excavation	6,327	6,313	6,313	6,294	6,252	
Tile and plaster	7,702	7,371	7,371	7,345	7,297	
Sash and glazing	11,421	10,828	10,828	10,794	10,287	
Doors	2,278	2,215	2,215	2,158	2,143	
Miscellaneous iron	7,003	6,987	6,987	6,971	6,922	
Roofing, flashing & vents	2,574	2,568	2,568	2,562	2,544	
Wood walk on roof	64	64	64	64	64	
Painting	1,609	1,605	1,605	1,601	1,590	
Liability insurance	2,574	2,568	2,568	2,562	2,544	
Engineering, plans, supt., etc.	6,757	6,741	6,741	6,725	6,678	
	$190,904	$190,920	$190,920	$189,196	$187,003	

Vaporized Metal Sprayed on Surfaces by Hot Blast

Bronze covered statues, copper covered shingles, concrete piles, or railroad ties, and gold covered furniture are some of the possibilities of a process for spraying metals, being studied at the U. S. Bureau of Standards. An exhibit showing stone, cement, metal, wood, and glass, which had been coated by the new process, attracted attention when shown by the Bureau in the recent Chemical Industries Exhibition in New York.

The essential of the process is that the metal is first vaporized and then sprayed onto the surface to be coated by means of a powerful blast, which congeals it to the solid form as quickly as it strikes the surface. Details of the process are withheld by the Bureau at present for military reasons, except for the statement that it is based on a new principle and that electricity is used in the vaporization process.

Applications of the method, which results in a firm coating of metal upon any surface to which it is applied, are many and varied. Stone, wood, metal, and glass are all equally suitable basic surfaces. Pottery may be successfully coated with metal, pointing to important developments in the ceramic industries.

An important application is in the use of the metal coating in building construction. Shingles may be made fire resisting by coating them with copper, which weathers well and produces an artistic green color on the roof. Experiments are already being made along the lines of copper coating other roofing material.

Soldering of metal to glass, a difficult problem, has been easily accomplished by means of this method. The glass is first coated with a layer of copper, and the metal connection is then soldered to the copper. Processes somewhat similar are used in the soldering of aluminum.

The preservative qualities of metal-coated articles are attracting attention from many quarters. It may be used in airships and is being experimented with as a marine paint for naval vessels, certain alloys being highly resistant to salt-water corrosion and inhospitable to the growth of barnacles. For the same reason, it may be used to protect piling, and its preservative action may also be used to conserve railroad ties.

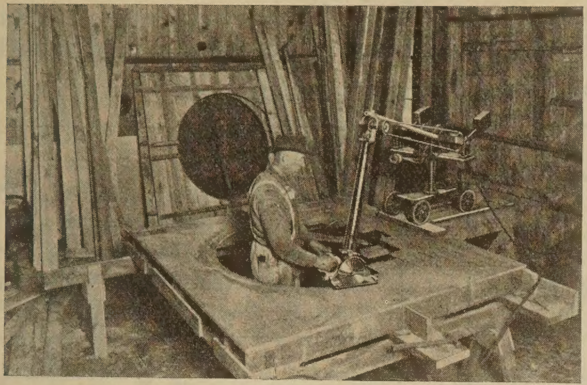
On the decorative side the uses of the method are many. Statues or other sculptured designs may be hewn from soft and easily worked stone and then coated with bronze, giving the effect of a bronze statue and weathering equally as well. Gold plating or decoration may be applied in the same way to furniture or table ware.

A coating of copper one thousandth of an inch in thickness may, so its inventors say, be applied at the rate of two square feet a minute, and at a cost of two cents a square foot, exclusive of the cost of labor. Cheaper and more easily fusible metals, such as lead, would cost less.

Concrete Products Manufacturers of Illinois

A Concrete Products Advisory Council has been selected by 300 products manufacturers in Illinois. The men who received the highest number of votes are listed below: E. W. Hilker, Granite City; Lacy Peyton, Benton; Jacob Bosch, of the Calumet Concrete Products and Material Co., Chicago; George Zeigle, Peoria; Gil Cooper, Joliet.

Portable Wood Worker



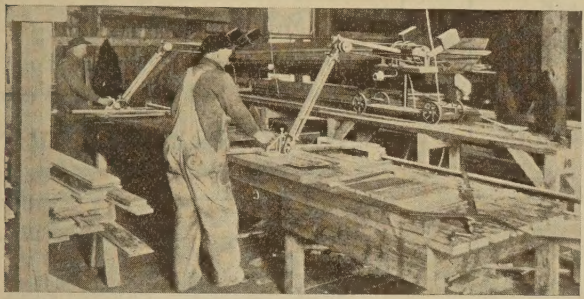


Fig. 1—Using the Flexway Equipment for Cutting Circles for Column Heads

Fig. 2—The Flexway Equipment in Use. The Ends of Panels Can Be Cut Off Without Moving the Panels After the Battens Are Nailed On

The accompanying illustrations show a new portable wood working machine known as the Flexway machine. The smallest type size No. 1 is used by contractors in making forms for concrete with a considerable saving of time in various ways. With adjustable squares on which the saw frame travels, the operator cuts off the forms to an exact length, either square or beveled edges, in less time, it is claimed, than it formerly took to draw the lines to be followed in sawing the panel off with a hand saw.

By the use of the concaved saw and a radius rod, this machine also cuts a circle for column caps, etc. Machine No. 1, equipped with a 1½ h. p. motor will cut off 2-in. stock; No. 2, 3 h. p. motor will cut off 4-in. stock;No. 3, with 5 h. p. motor will cut 8-in. stock and the No. 4 with 7½ h. p. motor will cut 10-in. stock. The equipment, which has been on the market for about 2 years is adaptable to the job, shop and yard in connection with building operations. It is manufactured by the P. L. Billingsley Co., Cincinnati.

Cinder Partition Block

The King Partition Block Co., Long Island City, N. Y., is manufacturing hollow cinder partition block in thicknesses of 2 in. to 6 in. They are extremely light in weight, a 12-in. x 12-in. x 2-in. unit weighing 8½ lbs. The product has been accepted by the building departments of Queens and Manhattan for non-bearing wall work, and is meeting a good reception by builders who are looking for a block that will hold plaster readily and that can be used both as protection work around steel columns and in partitions.

Leslie Allen Leaves Cement Association

Leslie H. Allen has become associated with Russell Barr Williamson, architect, 403 Broadway, Milwaukee, Wis., as partner and business manager. Mr. Allen has for the last two and a half years been in charge of the Concrete House Division of the Portland Cement Association and prior to that was for two years with Fred T. Ley & Co., New York, and for eleven years with the Aberthaw Construction Co., contracting engineers, Boston. Mr. Williamson is one of the leading architects in Milwaukee with an extensive practice specializing in hotels, apartment houses and residential work.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 1807 East Grand Boulevard, Detroit. Convention February 25 to 28, incl., 1924, Drake Hotel, Chicago.

American Concrete Pipe Association; M. W. Loving, Secretary, 111 West Washington St., Chicago. January 17-19, Sherman Hotel, Chicago.

American Engineering Standards Commission; Dr. P. G. Agnew, Secretary, 29 W. Thirty-ninth Street, New York City.

Associated General Contractors of America; G. W. Buchholz, Secretary, 1038 Munsey Bldg., Washington, D. C. January 21-23, Chicago.

Associated Metal Lath Manufacturers; 123 W. Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference; Rudolph P. Miller, President, Fred W. Lumis, City Hall, Springfield, Mass., Secretary.

Iowa Cement Stave Silo Association; H. E. Kilmer, Secretary, Oskaloosa, Ia.

Iowa Concrete Products Association; Ross Dowell, Secretary, 405 Hubbell Bldg., Des Moines.

Mid-West Concrete Products Association; D. R. Donlen, Secretary-Treasurer, 4340 Marcy St., Omaha, Neb.

National Association of Manufacturers; John E. Edgerton, President; Henry Abbott, Treasurer; George S. Boudinot, Secretary, 50 Church St., New York City.

The National Concrete Stave Silo Association; W. G. Kaiser, Secretary, 111 West Washington St., Chicago.

National Crushed Stone Association; A. P. Sandles, Secretary, 405 Hartman Bldg., Columbus, Ohio.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 East 22nd St., N. Y. C.

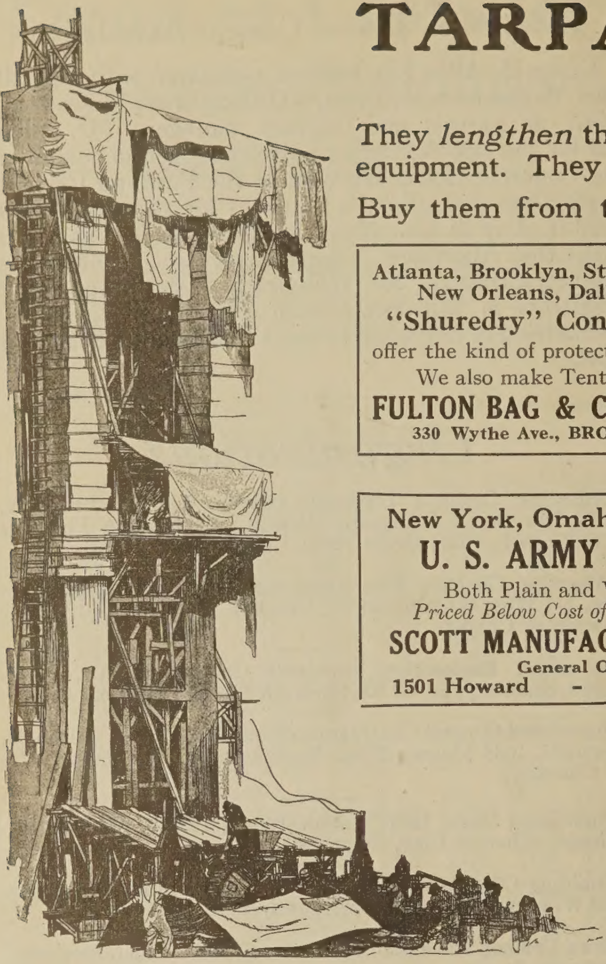
The National Lime Association; Mather Bldg., Washington, D. C.

National Sand and Gravel Producers' Association; T. R. Borrows, Acting Secretary, 903 Munsey Bldg., Washington, D. C.

Portland Cement Association; William M. Kinney, General Manager, 111 West Washington Street, Chicago.

Wisconsin Concrete Products Association; D. R. Collins, Secretary-Treasurer, Milwaukee.

Truscon Metal Lath Data Book is the title of a booklet put out by the Truscon Steel Co., Youngstown, Ohio. Paper covers; 8½ in. x 11 in.; 48 pages; illustrated. This booklet is considered the most complete data book ever published on metal lath, for architects and plastering contractors. It is the result of an investigation covering more than a year, during which period, practical uses of metal lath were studied, thus the Truscon Metal Lath Data Book contains only the boiled down essence of practical metal lath information. Solid plaster partitions, walls, floors, roofs, attached and suspended ceilings, interior plastering and exterior stucco work are a few of the subjects that are fully covered.



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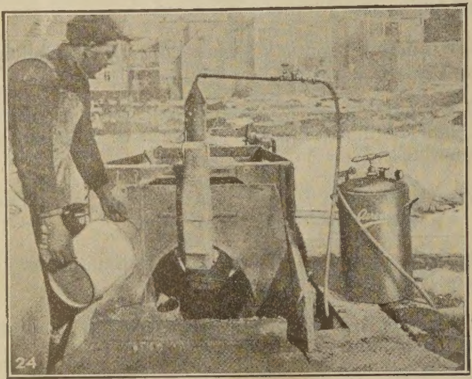

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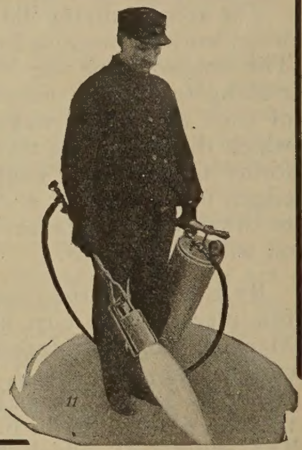

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